Lower Red River Meadow Restoration Project

Effectiveness Monitoring

Technical Report
1997 - 2001

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LOWER RED RIVER MEADOW RESTORATION PROJECT

BIENNIAL REPORT 1996-97

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ABSTRACT

The Red River has been straightened and the riparian vegetation corridor eliminated in several reaches within the watershed. The river responded by incision resulting in over-steepened banks, increased sedimentation, elevated water temperatures, depressed groundwater levels, reduced floodplain function, and degraded fish habitat. The Lower Red River Meadow Restoration Project is a multi-phase ecosystem enhancement effort that restores natural physical and biological processes and functions to stabilize the stream channel and establish high quality habitats for fish and wildlife. A natural channel restoration philosophy guides the design and on the ground activities, allowing the channel to evolve into a state of dynamic equilibrium. Two years of planning, two years of restoration in Phases I and II, and one year post-restoration monitoring are complete. By excavating new bends and reconnecting historic meanders, Phase I and II channel realignment increased channel length by 3,060 feet, decreased channel gradient by 25 percent, and increased sinuosity from 1.7 to 2.3. Cross-sectional shapes and point bars were modified to maintain deep pool habitat at low flow and to reconnect the meadow floodplain. Improved soil moisture conditions will help sustain the 31,500 native riparian plantings reestablished within these two phases. Overall, short-term restoration performance was successful. Analyses of long-term parameters document either post-restoration baseline conditions or early stages of evolution toward desired conditions. An adaptive management strategy has helped to improve restoration designs, methods, and monitoring. Lessons learned are being transferred to a variety of audiences to advance the knowledge of ecological restoration and wise management of watersheds.

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List of Acronyms

Acronym	Description
ATV	all-terrain vehicle
BPA	Bonneville Power Administration
cfs	cubic feet per second
DEQ	Idaho Department of Health and Welfare's Division of Environmental Quality
IDWR	Idaho Department of Water Resources
ESU	Ecologically Significant Unit
GIS	Geographic Information System
GPM	General Parr Monitoring
GPS	Global Positioning System
HEP	Habitat Evaluation Procedure
HIS	Habitat Suitability Index
IDFG	Idaho Department of Fish and Game
ISG	Independent Scientific Group
ISWCD	Idaho County Soil and Water Conservation District
LRRMRP	Lower Red River Meadow Restoration Project
NMFS	National Marine Fisheries Service
NPNF	Nez Perce National Forest
NPT	Nez Perce Tribe
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity units
NWPPC	Northwest Power Planning Council
PWI	Pocket Water, Inc.
RME	River Masters Engineering
RRWMA	Red River Wildlife Management Area
SCC	Soil Conservation Commission
SFC	South Fork Clearwater
TAC	Red River Technical Advisory Committee
UI	University of Idaho
USFWS	US Fish and Wildlife Service
USACE	US Army Corps of Engineers
USDA	United States Department of Agriculture
WHI	Wildlife Habitat Institute

EXECUTIVE SUMMARY

Looking north through the valley of the Lower Red River. The 4.4-mile stretch of river and wet meadow habitat is the site of the Lower Red River Meadow Restoration Project.

The Lower Red River Meadow Restoration Project is a multi-phase ecosystem enhancement endeavor that restores natural physical and biological processes in an effort to stabilize the Lower Red River channel, reestablish native riparian plant communities, and enhance the quantity and quality of fish and wildlife habitat.

Funded by the Bonneville Power Administration as part of the Northwest Power Planning Council's Fish and Wildlife Program, the project is one of many efforts at off-site mitigation for damage to salmon and steelhead runs and wildlife habitat caused by the construction and operation of federal hydroelectric dams on the Columbia River and its tributaries.

Several decades of human disturbances in the Red River watershed have resulted in the current degraded condition of the river and its associated fish and wildlife habitats.

This report represents the first comprehensive review of baseline conditions and restoration progress since project inception in 1994. Descriptions of events leading up to and including the implementation of the first two phases of the Lower Red River Meadow Restoration Project are included. The period of record spans two years of planning (1994, 1995), two years of restoration activities (1996, 1997), and one year of post-restoration monitoring (1997). Documenting and disseminating information related to project background, planning, restoration experiences, and initial monitoring results fulfills two purposes. First, the information adds to public and agency awareness and scientific knowledge of the relatively new and rapidly changing field of ecological restoration. Second, this report fulfills the annual progress reporting obligation to the Bonneville Power Administration (BPA) and the Northwest Power Planning Council (NWPPC).

BACKGROUND

The Red River is the easternmost tributary of the South Fork Clearwater River and part of the larger Columbia River Basin. Located in north central Idaho near the town of Elk City, the Lower Red River Meadow is surrounded by Nez Perce National Forest land and situated at an elevation of 4,200 feet. The lower meadow is comprised of four separate land parcels (≈ 1,300 acres or 526 hectares) and, prior to restoration work, approximately 4.4 miles (7.1 kilometers) of stream channel.

Human activities on various geographic scales have had an accumulative impact on the ecology of the Lower Red River Meadow. Construction of reservoirs and hydroelectric dams in the Snake and Columbia river systems downstream has inhibited the migration of anadromous fish species. On a watershed scale, logging, mining, and road-building practices have altered the hydrology, sediment delivery, and water quality characteristics of the Red River. On a local scale, the river channel has been straightened and native riparian vegetation eliminated due to dredge mining or in an attempt to reduce flooding and maximize grazing area throughout the meadow. As a result, the channel gradient and the water's erosive power have increased, accelerating streambank erosion rates and streambed scour. The groundwater table has lowered and the meadow floodplain inundates less frequently, reducing the ability of soil moisture conditions to sustain the once prevalent native riparian plant communities. Elevated summer water temperatures, reduced quantity and diversity of instream fish habitat, and elevated levels of suspended sediment and fine sediment deposition provide suboptimal fish spawning and rearing conditions. Fish populations in the Red River have declined, in part, in response to these degraded conditions.

The Red River watershed is classified as a "historic stronghold" for spring chinook salmon, steelhead trout, bull trout, and westslope cutthroat trout. The watershed, particularly the meadow reaches, contains a disproportionately high amount of aquatic potential within the South Fork Clearwater subbasin and is a high priority for restoration activities.

One of the four parcels in the lower meadow came up for sale in 1993. A group of agencies and organizations [BPA, Idaho Department of Fish and Game (IDFG), Rocky Mountain Elk Foundation, Trout Unlimited, National Fish and Wildlife Foundation, and the US Forest Service] recognized an opportunity to protect and restore fish and wildlife habitat and collaborated to purchase the property. The combination of existing and potential fish and wildlife habitat and the structural facilities (ranch house, caretaker's house, and out-buildings) on the property offered an extraordinary setting for a conservation education center as well. In 1994, the property was deeded to IDFG in a Memorandum of Agreement with BPA to manage in perpetuity for fish and wildlife benefits as the Red River Wildlife Management Area (RRWMA). A successful funding proposal to BPA in 1994 initiated planning for the Lower Red River Meadow Restoration Project. The project team consists of the Idaho County Soil and Water Conservation District (project sponsor), private technical consultants, and an agency and tribal Technical Advisory Committee.

The overall mission of the project is to use the restoration work as a demonstration, using a holistic watershed approach, to restore the Lower Red River Meadow to a naturally functioning river/wet meadow ecosystem. Project goals include increasing the quality and quantity of fish and wildlife habitat, improving water quality, and promoting watershed restoration education. The project team chose a natural channel design philosophy where the engineering design guides the channel into a stable state called *dynamic equilibrium*. In a natural stable state, a meandering stream will migrate laterally across a meadow, but will retain its cross-sectional shape. During this dynamic process, a stream adjusts its form in response to natural fluctuations in discharge and sediment in order to maintain a balance between sediment supply and sediment transport; slow rates of erosion on outside bends are balanced by similar rates of deposition on inside point bars.

Restoration of the 1.5 miles (2.4 kilometers) of stream on the RRWMA was divided into four phases with the intent of completing one phase per year, beginning on the upstream end of the property (Phase I) and finishing on the downstream end (Phase IV). Additional phases will move restoration work to willing landowners upstream and downstream of the RRWMA.

ENGINEERING AND CONSTRUCTION

The focus of the engineering design and construction work is to restore the natural physical characteristics, including channel cross-sectional shape, sinuosity, gradient, sediment transport regime, and floodplain function. Soil moisture conditions improve as the channel narrows, surface water elevations increase, and normal flood flows extend onto the meadow floodplain. Adequate soil moisture conditions are necessary to reestablish and sustain native riparian plant communities. As the channel evolves toward a stable state and native riparian vegetation matures, erosion rates will decrease, water quality will improve, and diverse and high quality fish and wildlife habitat will develop.

All in-channel work is conducted during July 1st – August 15th, according to conditions and restrictions set forth within stream alteration permits, to minimize construction-related impacts to spawning, rearing, and migration of anadromous and resident fish. Best management practices are used during construction activities to reduce, or otherwise avoid, soil suspension or deposition into the live stream channel.

Phase I (1996) and Phase II (1997) engineering accomplishments included reconnecting two historic channel meanders (Goose Island Bend and Historic S-Curve Loops), constructing two new meanders (Big Bend and Giant Bend), and accentuating three existing outside bends (Two-Sill Bend, Hopeful Bend, and Ninety-Degree Bend). Changes to the channel alignment increased channel length on the entire RRWMA by 3,060 feet (933 meters), decreased channel gradient by 25 percent, and increased sinuosity from 1.7 to 2.3. Channel cross-sectional shapes and point bars were modified or created to maintain deep pool habitat during low flows, convey average annual flows within the channel, and dissipate flood flows onto the floodplain. Six rock grade control structures were installed to raise low flow surface water and groundwater elevations.

A pond/wetland area, approximately 200 feet by 125 feet (61 meters by 38 meters) was constructed in Phase II to provide additional shallow and open water habitat for waterfowl and other wetland dependent species. Several log habitat structures were keyed into the outside streambanks of Big Bend and Hopeful Barb Bend. On the entire RRWMA, fish habitat area increased by approximately 35 percent. In Phases I and II alone, fish habitat area increased by nearly 95 percent. Both the number of pool/riffle sequences and residual pool depths increased by approximately 60 percent.

Engineering accomplishments during the first two years of this multi-phase project represent the initial steps toward the evolution of the Lower Red River into a state of dynamic equilibrium. As the channel stabilizes with time, reduced stream bank and bed erosion rates and improved water quality are expected. Increases in both surface water and groundwater elevations will enhance soil moisture conditions and reconnect tributary mouths, backwater channels, and other off-channel rearing habitat to the main channel.

REVEGETATION

The engineering and revegetation components of the project have a synergistic effect. Lengthening the stream and installing grade control structures help to increase surface water elevations as well as floodplain inundation frequency and duration. In turn, these improved hydrologic conditions provide soil moisture necessary for the establishment and sustainability of native riparian plant communities.

Species comprising the once prevalent native plant communities were hypothesized using on-site and adjacent land surveys, current published literature, historical data and photographs, and local accounts of historical conditions. On wetter sites near the stream channel and in off-channel depressions, communities of Drummond willow/beaked sedge *(S. drummondiana/Carex rostrata*) or Geyer willow/beaked sedge *(S. geyeriana/C. rostrata)* are expected to develop. On drier sites at the outside edges of the riparian zone and slightly drier meadow areas, communities of willows/bluejoint reedgrass *(Salix spp./Calamagrostis canadensis)* or willows/tufted hairgrass *(Salix spp./Deschampsia cespitosa)* are expected to develop.

Active replanting is necessary since elimination of the original woody riparian corridor, both on the project site and upstream, reduced seed sources to numbers incapable of supporting natural recruitment. As plantings become established and soil moisture conditions are restored, natural recruitment and regeneration are expected.

Revegetation design criteria were developed to meet project philosophy, goals, and objectives. All herbaceous wetland/riparian plant seed are collected on site. Dormant willow pole cuttings are collected on nearby sites having similar elevation, temperature, and precipitation conditions. Planting locations are selected according to the hydrologic requirements and big game palatability of a particular species. An erosion control seed mix is sown in newly exposed soil disturbed by construction activities such as reinforced banks, former channel areas, and access roads. Erosion control fabric is placed on areas most vulnerable to erosion. Due to low rainfall, typical during the summer months in the lower meadow, irrigation is supplied where necessary to ensure quick establishment and improve survival rates of newly sown seed and planted seedlings.

During the 1996 and 1997 field seasons, 31,500 woody and herbaceous riparian plants were planted in a 20-foot (6-meter) riparian buffer along the stream reaches of Phases I and II. An erosion control seed mix consisting of 1,400 pounds (635 kilograms) of five native grass and one naturalized forb species and 600 pounds (272 kilograms) of ReGreen™ was sown. Planted areas were supplied with a total of 2,570 pounds (1,166 kilograms) of fertilizer. Coir fiber erosion control matting was installed on the four reinforced banks. Eight wildlife exclosures were constructed and planted with native woody species to limit and monitor ungulate browsing and to quickly establish dense islands of vegetation for future seed sources.

In the long-term, streambank vegetation will become the natural stabilizing force, reducing erosion rates and providing shade, cover, and nutrient sources for aquatic organisms and fish. A dense and diverse riparian community will enhance wildlife habitat by providing food, cover, and nesting habitat for waterfowl, birds, and terrestrial mammals and will help lower stream temperatures as overhanging vegetation and stable undercut banks develop.

MONITORING AND EVALUATION

Restoration work must often be implemented without complete scientific knowledge of outcomes. Therefore, the project monitoring program measures, evaluates, and documents the results of restoration efforts against established quantitative and qualitative performance criteria. Using adaptive management principles, engineering and revegetation designs and implementation procedures are improved in future restoration phases. Monitoring parameters, performance criteria, and methodology are also refined. As information and data are collected, techniques and experiences are being transferred to other natural resource managers and stewards. All monitoring data is integrated into a project database and an ArcView Geographic Information System (GIS) that is maintained and updated by the University of Idaho (UI).

The Lower Red River Meadow Restoration monitoring program measures five short-term, or *implementation*, parameters and six long-term, or *effectiveness*, parameters. Implementation parameters are those measured during the field season or one to two years post construction and include turbidity and suspended sediment, erosion control, planting success, browsing impacts, and qualitative field reviews by the Technical Advisory Committee. Effectiveness parameters are those measured at set intervals over several years or decades and include stream channel response, fish microhabitat features, fish populations, summer water temperature regime, groundwater elevation, and riparian condition.

Monitoring data collected during the 1997 field season in Phases I and II has been analyzed and compiled into an annual monitoring report. With one exception (turbidity levels occasionally exceeded water quality standards for a limited time), the project's short-term, or implementation performance, was successful. Project-related sediment load, estimated at 124 tons immediately below construction and 135 tons at the end of the meadow, was below the performance criterion limit of 150 tons. The average first-year survival rate of all herbaceous and woody riparian plantings equaled 83 percent, well above the established performance criterion of 50 percent.

Post-restoration measurements of sinuosity, gradient, pool numbers, and average residual pool depth achieved the established performance criteria. Analyses of the remaining long-term, effectiveness parameters document either baseline post-restoration conditions or early stages of evolution toward desired conditions. Evolution of the stream channel and associated wet meadow ecosystem into a state of dynamic equilibrium will occur during the next several years or decades. Tracking the incremental steps of this evolution allows the project to identify aspects of the design and implementation that may need improvement in future phases of the restoration.

The project team gained valuable experience in several areas of river restoration and has used these lessons to modify and improve designs, implementation procedures, and monitoring protocol. For instance, the log habitat structures placed in the outside banks of Phase I (1996) proved ineffective as fish habitat and were excluded from Phase II (1997) design. Microhabitat data results allowed the engineering designers to select model reaches that satisfied the performance criteria for spawning and rearing habitat as guides for Phase III and IV design. Field observations of Historic S-Curve Loops suggest that slightly narrower channel cross-sections develop higher quality fish habitat and evolve toward dynamic equilibrium sooner than cross-sections previously designed in Phases I and II. Narrower channels will be designed for Phases III and IV.

During implementation, the project team gained an understanding of the relationships between proper construction sequencing and adequate timing that ensures the slow release of construction-induced turbid water. Knowledge of these relationships is key to mitigating suspended sediment impacts and will be incorporated into future restoration work. The project team also gained experience working in above average rainfall and stream discharge conditions and recognized the value of effective contingency plans.

The turbidity monitoring protocol was refined and data collection stations expanded during the 1997 field season to coordinate activities with downstream users and to document turbidity levels. The continuous availability of turbidity data allowed the construction team to quickly respond to short-term turbidity levels that rose above the water quality standard.

Analysis of monitoring methodology and usefulness of data resulted in several improvements to the monitoring plan for the upcoming years. Habitat mapping will be integrated with thalweg and cross section surveys to improve accuracy and repeatability. Microhabitat measurements will target rearing and spawning habitat in comparison to local reference sites rather than to values provided in the literature. Measurements of additional habitat variables, bank stability, overhanging vegetation, and undercut banks will be added to the effectiveness monitoring parameters to improve documentation of fish habitat enhancements resulting from the restoration activities.

EDUCATION AND PUBLIC INFORMATION

The combination of existing and potential fish and wildlife habitat, the stream restoration demonstration project, and the structural facilities (ranch house, caretaker's house, and out-buildings) on the RRWMA offers a unique setting to provide both outdoor and indoor classroom experiences for students of all ages. Educational materials and indoor learning activities serve to disseminate information regarding successes, challenges, and experiences of the habitat restoration and enhancement efforts on the RRWMA. As an outdoor laboratory, the site is being used as a local and regional model and demonstration project and as a place where humans can observe the implications of fish and wildlife habitat degradation, understand the importance of wise management of watersheds, and appreciate the science of ecological restoration.

As the landowner and manager of the RRWMA, IDFG has a strong interest in the natural resources education potential of this property. In 1996, the IDFG drafted an education management plan. In 1997, the project team identified a number of education and public outreach activities having the potential to disseminate knowledge and experiences gained from the restoration activities. By the end of 1997, the project team and IDFG produced informational materials and accomplished several education and public information activities including public information meetings, on-site tours, a watchable wildlife platform, on-site informational signs, restoration project brochure, illustrative drawings, and CD-ROM image library. The project was filmed for two television programs. And, the RRWMA provided housing and facilities for a University of Idaho student surveying field trip.

In future years, the project team plans to enhance and accelerate these educational and public outreach efforts in cooperation with IDFG, University of Idaho, education-based foundations, and local and regional school districts and community organizations.

SUMMARY AND CONCLUSIONS

The Lower Red River Meadow Restoration Project is a cooperative, well-planned effort and part of the Northwest Power Planning Council's Fish and Wildlife Program to protect and enhance fish and wildlife populations and habitat within the Columbia River Basin. The project team uses a natural channel design and an ecosystem approach to guide the river/wet meadow ecosystem into a state of dynamic equilibrium. Benefits will accrue not only to fish and aquatic species, but to waterfowl, wetland- and riparian-dependent species, and upland wildlife as well.

The first two phases of restoration work on the Red River Wildlife Management Area, one of the four properties in the lower meadow, are complete. The stream channel was lengthened, cross-sectional shapes were modified, and native riparian plantings were installed. One year post-restoration monitoring results are encouraging. With one exception, short-term performance was successful. Analyses of long-term monitoring parameters document either post-restoration baseline conditions or early stages of evolution toward desired conditions. Achieving a state of dynamic equilibrium will take several years to decades. As the channel stabilizes and planted vegetation matures, reduced stream bank and bed erosion rates, improved water quality, decreased sedimentation, and enhanced pool and riffle habitat are expected. The project team has used restoration experiences to modify and improve designs, implementation procedures, and monitoring protocol. Lessons learned are being transferred to a variety of audiences to advance the knowledge of ecological restoration and wise management of watersheds. Continued successes and conservation education opportunities are expected to encourage the expansion of habitat protection and enhancement within the entire Red River watershed.

INTRODUCTION

Looking south at the upstream one-third of the Lower Red River Meadow, including a portion of the IDFG's Red River Wildlife Management Area (foreground) and the adjacent upstream property (background).

The Red River is located in north central Idaho and forms the easternmost tributary to the South Fork Clearwater River. Since the early part of the 20th century, human activities, on various geographic scales, have resulted in the degradation of the river and its associated fish and wildlife habitats.

The Lower Red River Meadow Restoration Project is part of the Northwest Power Planning Council's (NWPPC) Columbia Basin Fish and Wildlife Program (FWP). As part of the FWP, the project is one of Bonneville Power Administration's (BPA) many efforts at off-site mitigation for damage to salmon and steelhead runs and wildlife habitat caused by the construction and operation of federal hydroelectric dams on the Columbia River and its tributaries. The project is sponsored by the Idaho County Soil and Water Conservation District (ISWCD) and is a cooperative effort of a 20-member Technical Advisory Committee (TAC) composed of agency and tribal representatives and a team of private consultants.

The Lower Red River Meadow Restoration Project (LRRMRP) is a multi-phase endeavor that restores natural physical and biological processes in an effort to stabilize the Lower Red River channel, reestablish native riparian plant communities, and enhance the quantity and quality of fish and wildlife habitat. Target species include chinook salmon *(Oncorhynchus tshawytscha)*, steelhead trout *(Oncorhynchus mykiss)*, bull trout *(Salvelinus confluentu*s), and westslope cutthroat trout *(Oncorhynchus clarki lewsi)*.

An ecosystem approach focuses efforts on reestablishing the relationships among the river channel, floodplain, riparian corridor, wet meadow, and adjacent upland habitats. Benefits accrue not only to fish and other aquatic organisms, but also to waterfowl, wetland- and riparian-dependent species, and upland wildlife.

This report represents the first comprehensive review of baseline conditions and restoration progress since project inception in 1994. Documenting and disseminating information related to project background, planning, restoration experiences, and initial monitoring results fulfills two purposes. First, the information adds to public and agency awareness and scientific knowledge of the relatively new and rapidly changing field of ecological restoration. As a demonstration and educational site, the LRRMRP hopes to increase the successes of other similar efforts and contribute to the development of regional guidelines for river and habitat restoration. Second, this report fulfills the annual progress reporting obligation to BPA and the NWPPC.

Events are described leading up to and including the implementation of the first two phases of the LRRMRP. This time frame includes two years of planning (1994, 1995), two years of restoration activities (1996, 1997), and one year of post-restoration monitoring (1997). Unless otherwise noted, all data, information, and accomplishments described and summarized herein are based on the best knowledge available at the commencement of Phase I and II restoration activities.

In the following chapters, the Lower Red River Meadow Restoration story unfolds. Chapter 3 describes the background of the project including site location, pre-existing conditions, project inception and organization, and restoration planning.

Chapter 4 explains engineering design criteria, regulatory considerations, best management practices, constructed features and expected outcomes, and engineering accomplishments.

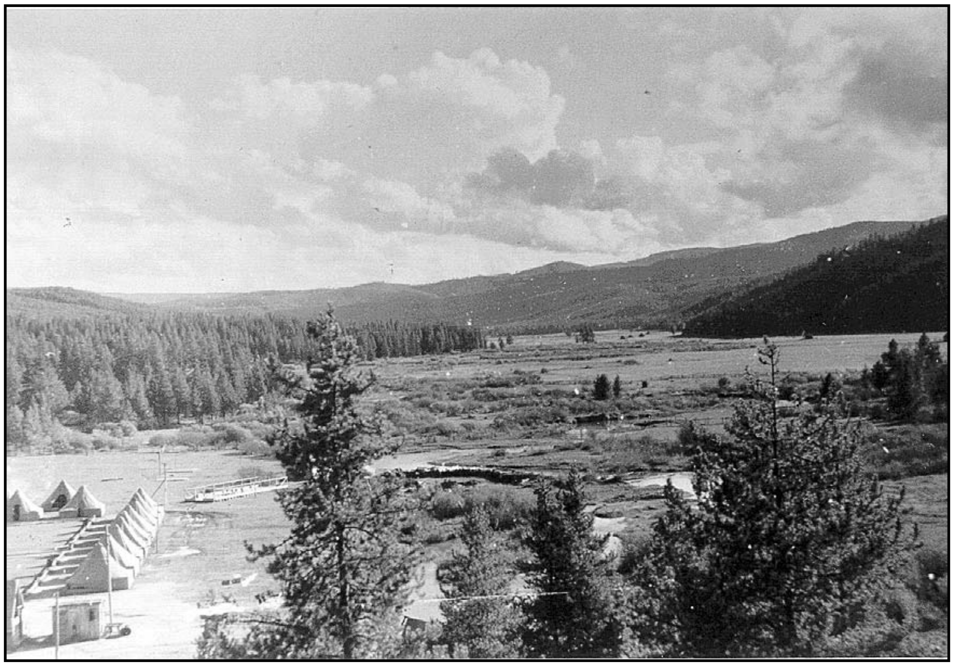
Chapter 5 provides revegetation details consisting of revegetation design criteria, planting design and methods, accomplishments and challenges, and expected outcomes.

Chapter 6 gives an overview of the project's monitoring program; describes monitoring parameters, methods, and performance criteria; evaluates short- and long-term performance; and discusses adaptive management implications.

Chapter 7 briefly outlines education and public information plans, accomplishments, and visions.

Chapter 8 summarizes and concludes project progress and accomplishments and describes future expectations.

BACKGROUND



The Lower Red River Meadow was the location of a Civilian Conservation Corps (CCC) camp in 1939. Notice the dense riparian shrub communities along the river channel (looking southwest).

The headwaters of the Red River form in north central Idaho about four miles northwest of Green Mountain in the Clearwater Mountain Range. Flowing northwest about 28 miles (45 kilometers), the Red River joins the American River to become the South Fork Clearwater River (Figure 3.1) and part of the larger Columbia River Basin. The river is the easternmost tributary of the South Fork of the Clearwater River and drains approximately 100,000 acres (40,470 hectares). The Red River watershed is one of 14 major watersheds in the South Fork Clearwater (SFC) subbasin.

The Red River watershed is classified as a “historic stronghold” for spring chinook salmon, steelhead trout, bull trout, and westslope cutthroat trout. Several decades of human disturbances in the watershed have resulted in the current degraded condition of the river and its associated fish and wildlife habitats. The watershed, particularly the meadow reaches, contains a disproportionately high amount of aquatic potential within the SFC subbasin and is a high priority for restoration activities.

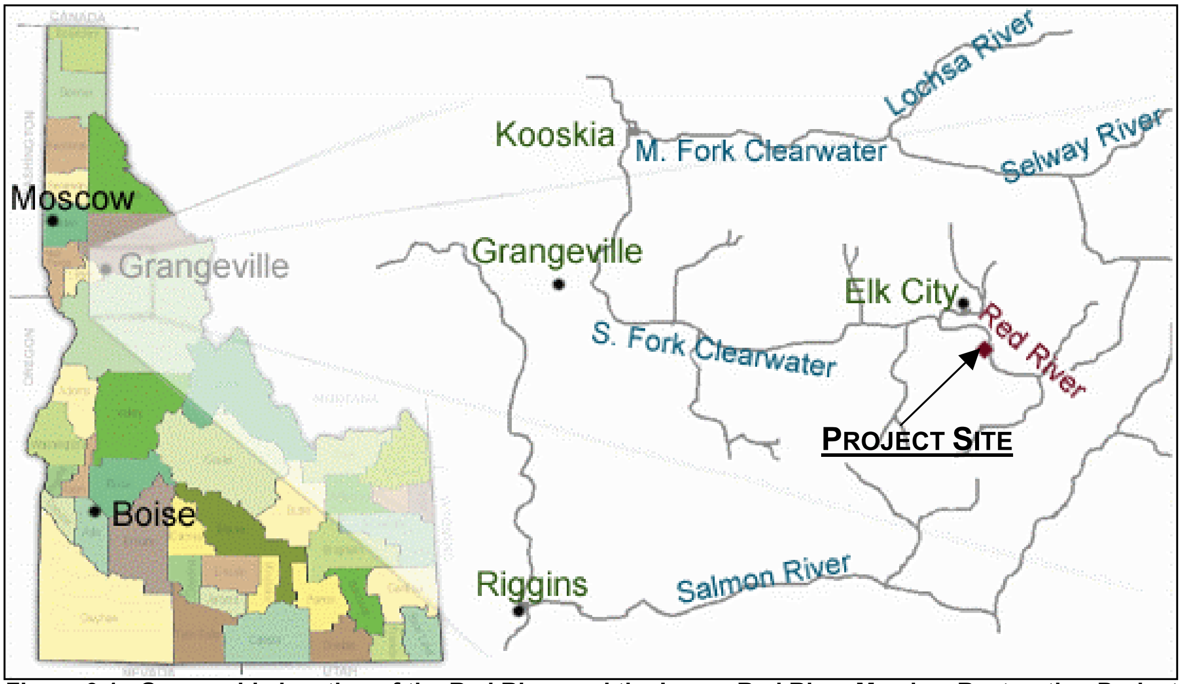


Figure 3.1. Geographic location of the Red River and the Lower Red River Meadow Restoration Project site near Elk City in Idaho County, Idaho.

3.1 PRE-EXISTING ECOSYSTEM CONDITIONS

Since the early part of the 20th century, human activities on various geographic scales have had an accumulative impact on the ecology of the Lower Red River Meadow. Construction of reservoirs and hydroelectric dams in the Snake and Columbia river systems downstream has inhibited the migration of anadromous fish species. On a watershed scale, logging, mining, and road-building practices have altered the hydrology, sediment delivery, and water quality characteristics of the Red River. On a local scale, the river channel has been straightened and native riparian vegetation eliminated due to dredge mining or in an attempt to reduce flooding and maximize grazing area throughout the meadow. The river/wet meadow ecosystem has responded in the following ways:

- the river's length and sinuosity have decreased, resulting in an increase in the channel gradient and the water's erosive power, and therefore, elevated levels of suspended sediment and fine sediment deposition;
- the channel bed has downcut, causing over-steepened, unstable streambanks and over-widened reaches;
- the groundwater table has lowered and the meadow floodplain inundates less frequently, reducing the ability of soil moisture conditions to sustain native riparian plant communities;
- the river maintains a reduced quantity and diversity of instream fish habitat (pools, riffles, overhanging banks, woody debris, spawning gravels); and
- summer water temperatures are elevated, providing suboptimal fish spawning and rearing conditions.

Land Use and Ownership

The Lower Red River Meadow (Sec. 19, T 28 N. – R 9 E., Boise Meridian, Moose Butte Quadrangle) is surrounded by Nez Perce National Forest land and situated at an elevation of 4,200 feet (1,280 meters). Several of the nearby peaks in the Clearwater Mountain Range reach 6,000 to 7,000 feet (1,829 to 2,134 meters). The lower meadow is comprised of four separate land parcels (≈ 1,300 acres or 526 hectares) and, prior to restoration work, approximately 4.4 miles (7.1 kilometers) of stream channel (Figure 3.2).

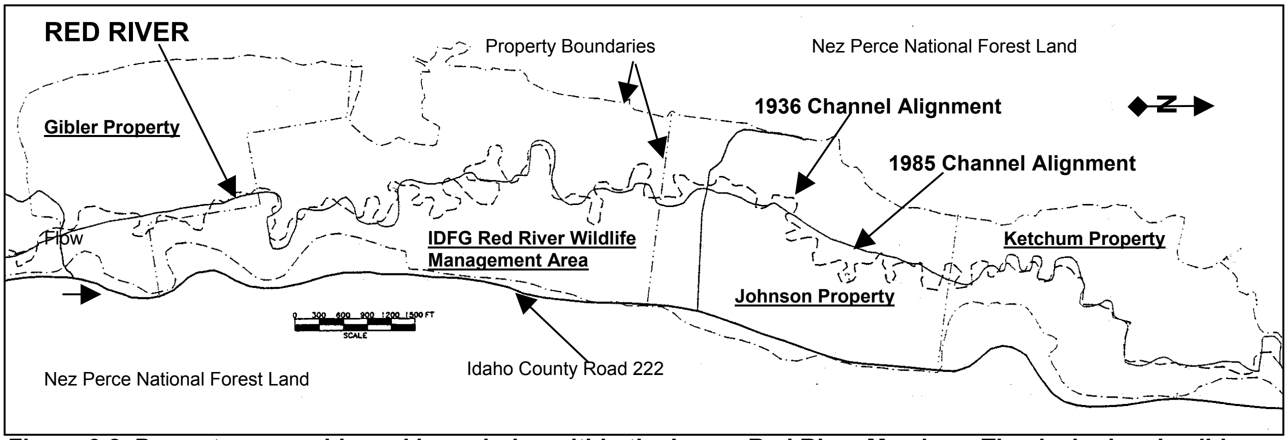


Figure 3.2 Property ownership and boundaries within the Lower Red River Meadow. The dashed and solid lines in the middle of the meadow represent the Red River channel alignment in 1936 and 1985, respectively [modified from River Masters Engineering (RME), 1995].

The Gibler Ranch, the most upstream land parcel at the south end of the meadow was homesteaded in the early 1900s. The property has since been divided among second and third generation family members and is currently used for vacation/recreation homesites and horse pasture. The river channel through this property was dredge mined for gold in the late 1940s and early 1950s and maintained in a straight alignment for grazing/haying purposes. The Gibler property included 3,375 feet (1,029 meters) of the Red River channel in 1936 and was reduced to 2,550 feet (777 meters) by 1985 (RME, 1995).

The Red River Wildlife Management Area (RRWMA) lies adjacent to and downstream of the Gibler property. Prior to its purchase in 1993, the RRWMA was used primarily for cattle and hay production and most recently operated as the Little Ponderosa Ranch. Cattle have not grazed the RRWMA since 1993 and the Idaho Department of Fish and Game (IDFG) now manages the property for fish and wildlife benefits. No dredge mining activities occurred on this property but several meanders were cut off for grazing/haying benefits. The RRWMA included 12,300 feet (3,749 meters) of Red River channel in 1936 and by 1985, only 7,950 feet (2,423 meters) (RME, 1995).

The Johnson Ranch, adjacent to and downstream from the RRWMA is currently operated for cattle and hay production. Cattle have free access to the riparian and streambank areas on this property. The river channel was straightened in the late 1940s and early 1950s primarily from gold dredge mining activities. The Johnson property included 6,900 feet (2,103 meters) of Red River channel in 1936 and reduced in length to 4,050 feet (1,234 meters) by 1985 (RME, 1995).

The Ketchum Ranch is currently leased during the summer months for agricultural (primarily hay production) and grazing purposes. During the months of June through October, cattle graze and water freely along the river. The portion of Red River flowing through the Ketchum property has neither been dredge mined nor straightened; therefore, current stream length (8,250 feet or 2,515 meters) is similar to that in 1936 (7,800 feet or 2,377 meters) (RME, 1995). However, accelerated streambank erosion and channel bed degradation are evident here as well due to cattle grazing, riparian shrub removal, and upstream channel alterations that caused increased water velocities downstream.

Channel and Riparian Zone Characteristics

The Lower Red River Meadow is characterized, geomorphically, as an unconfined alluvial valley (as defined by Minshall et al., 1989). The Red River flowing through the lower meadow is a low gradient, low velocity, meandering channel and generally corresponds to a C4 stream type based on the Rosgen Stream Classification System (Rosgen, 1996).

CHARACTERISTIC STREAM FLOWS. Stream flow records are available from two Forest Service gaging stations, approximately five miles upstream from the lower meadow.

Analysis of data recorded from 1986 to 1994 indicates that high flows in Red River usually occur between April and June. Because of the relatively short period of record documented by these gaging stations, historical stream gage records from similar tributaries in the Clearwater River Basin were also used to estimate characteristic stream flows for Red River. Average annual flows are approximately 136 cubic feet per second (cfs). Average flood flows are near 846 cfs and usually occur during the month of May. Low-flows occur from August through October and average 19 cfs. The average 10-year flood flow is approximately 1254 cfs; the average 100-year flood flow is near 1756 cfs (RME, 1995).

CHANNEL LENGTH, SINUOSITY, AND GRADIENT. Aerial photographs from 1985 and the preliminary site survey (1994) were used to estimate the pre-existing channel length, sinuosity, and gradient. Changes in stream length, sinuosity, and gradient from 1936 to 1985 are summarized by land parcel and for the entire meadow in Table 3.1. Visual changes in river and meadow conditions over 60 years are illustrated by contrasting a 1996 aerial photograph with one taken in 1936 (Figure 3.3).

The length of Red River flowing through the lower meadow has decreased by 25 percent with the greatest percentage decrease occurring on the Johnson Ranch (41 percent). In turn, the sinuosity (stream length/valley length) decreased from 1.9 in 1936 to 1.4 in 1985 with the greatest change occurring on the RRWMA, from 2.4 to 1.6 (RME, 1995).

As channel length decreases, channel gradient [(feet of water surface elevation drop/feet of channel length)(100)] increases. The largest increase occurred on the Johnson Ranch, from 0.17 percent in 1936 to 0.28 percent in 1985. The channel gradient in the entire lower meadow increased by 33 percent (0.18 to 0.24) between 1936 and 1985 (Table 3.1).

Table 3.1. Comparison of physical channel characteristics in the Lower Red River Meadow, by land parcel and entire meadow, from 1936 to 1985. Measurements are based on aerial photographs and preliminary site survey data (adapted from RME, 1995; BPA, 1996).

CHANNEL CHARACTERISTIC	LAND PARCEL				
	Gibler Ranch	**RRWMA**	**Johnson Ranch**	**Ketchum Ranch**	**Entire Meadow**
Channel Length* – 1936 *(feet)*	3,375	12,300	6,900	7,800	30,375
Channel Length* – 1985 *(feet)*	2,550	7,950	4,050	8,250	22,800
% Change	– 24	– 35	– 41	+ 6	– 25
Sinuosity – 1936 *(stream length/ valley length)*	1.32	2.41	1.80	1.68	1.88
Sinuosity – 1985 *(stream length/ valley length)*	1.00	1.56	1.06	1.77	1.41
Channel Gradient – 1936 (*percent) [(feet of water surface elevation drop/feet of channel length)(100)*]	0.23	0.17	0.17	0.19	0.18
Channel Gradient – 1985 *(percent) [(feet of water surface elevation drop/feet of channel length)(100)]*	0.30	0.26	0.28	0.19	0.24
Water Surface Elevation Drop** *(feet – measured in 1994)*	7.76	20.75	11.44	14.50	54.45

**Subsequent channel length measurements using Global Positioning System (GPS) ground survey data and Geographic Information System (GIS) measurement tools have improved the accuracy of the pre-restoration channel length measurements. The data presented here represent the best information available at the initiation of the project.*
***Assumption: Elevation change remained constant in the lower meadow from 1936 to 1994.*

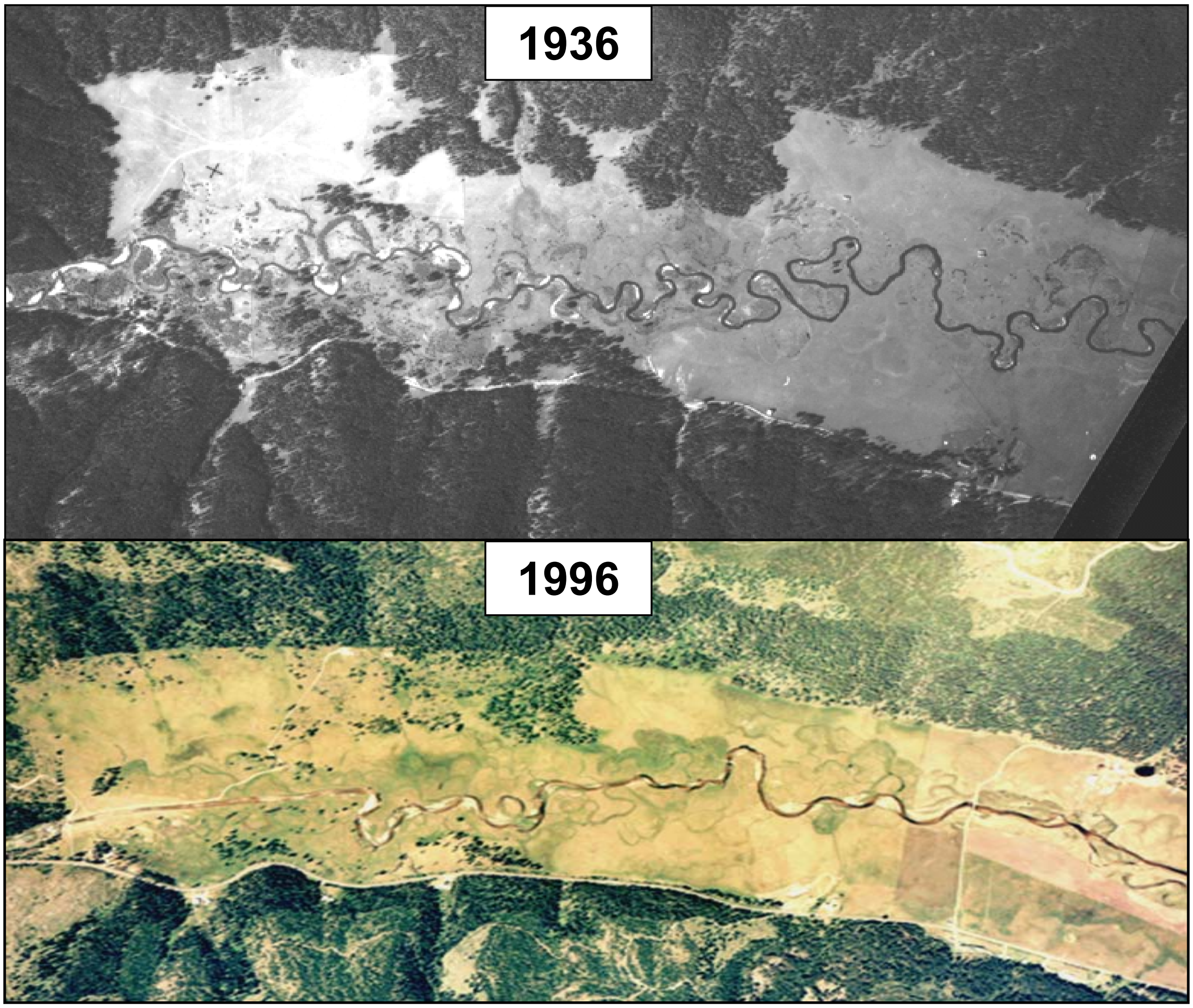


Figure 3.3 Comparison of changes in the Lower Red River channel length and sinuosity from 1936 to 1996. Note also changes in meadow and adjacent forest vegetation.

SOILS. Soils in the lower meadow formed in granitic alluvium and are similar to the Jughandle variant silt loams described in the Soil Survey for western Idaho County [Natural Resources Conservation Service (NRCS), 1982]. McGeehan (1995) evaluated soils at random sites within 100 yards (91.4 meters) of the channel on the RRWMA and the Gibler Ranch. In general, soil profiles display fine-textured surface horizons underlain by coarse-textured sands and gravels. Soil depths are variable, ranging from shallow to moderately deep; the soil-gravel interface varies from 15 inches (38 cm) to greater than 54 inches (137 cm) below the soil surface.

Streambank soils are experiencing accelerated rates of erosion as evidenced by slumping, shearing, and tension cracking. Compacted livestock trails and hoof pressure on unstable soils are evident along the streambanks on the Johnson and Ketchum Ranches [Pocket Water Inc. (PWI), 1994a].

Fine-textured soils are able to wick soil moisture upward through soil pores. This phenomenon is termed *capillary rise*. A laboratory experiment, performed using soil samples from the Red River's lower meadow, determined that these fine-textured surface soils are capable of wicking soil moisture upward 12 to 15 inches (30 to 38 cm) (McGeehan, 1995). Field observations of streambanks suggest that these soils may be capable of wicking moisture upward as much as 24 to 30 inches (61 to 76 cm). In either case, however, as water tables fall below the soil-gravel interface during late summer and early fall, capillary rise is prevented and plant-available moisture becomes limited in the root zone (McGeehan, 1995).

BANK STABILITY. Nearly every outside bend is characterized by an over-steepened, unstable vertical cut created primarily by accelerated erosional forces. Bank sloughing and collapse are common, exacerbated by the existing shallow, fine-rooted vegetation unable to bind the soils or form stable undercut banks. In addition, the coarse-textured sand/gravel subsurface layer is highly susceptible to erosive forces. Loss of this subsurface material eventually causes undermining of the surface layer and subsequent bank collapse (Figure 3.4).

A bank stability measurement of about 90 percent (<10 percent of total channel length actively eroding) characterizes a natural, undisturbed stream (NMFS, 1995; NWPPC, 1994). Average bank stability throughout the lower meadow ranges from 66 percent on the Gibler Ranch to 39 percent on the Ketchum Ranch (PWI, 1994a).

CHANNEL GEOMETRY. During the past several decades, increased water velocities and erosive energy caused the channel bed to incise, or downcut, an average of 1.5 to 2 feet (46 to 61 cm) throughout the lower meadow. Consequently, abandoned channels and tributary mouths are offset approximately 1 to 2 feet (30 to 61 cm) above the active stream channel (BPA, 1996; Brunsfeld et al., 1996).

Streambank heights range from 18 inches (46 cm) on the Johnson Ranch to 8 feet (2.4 meters) at the upstream end of the Gibler Ranch (PWI, 1994a). Over-steepened banks succumb to gravitational and erosional forces resulting in over-widened channels and shallow, low-flow surface water depths. Field estimates of bankfull widths throughout the lower meadow range from 65 to 200 feet (20 to 61 meters) (UI field survey notes, 1997).

Figure 3.4 A typical outside bank in the Lower Red River Meadow where shallow rooted, nonnative pasture grasses are unable to bind the streambank soils against the forces of erosion. The coarse-textured, sand/gravel subsurface layer is easily scoured out and eventually followed by collapse of the surface soil layer.

FLOODPLAIN HYDROLOGY. A drop in water table elevations accompanied channel incision. Increased distances between the top of bank and surface water level prevent normal flood flows from overtopping the banks and dissipating erosive energy onto the floodplain. Consequently, the floodplain is inundated less frequently and for a shorter duration, resulting in drier soil conditions throughout the meadow and reduced aquifer recharge.

RIPARIAN VEGETATION. Many plant species present along the streambanks in the lower meadow are those adapted to drier soil conditions. Non-native, shallow rooted pasture grasses and forbs average 45 to 69 percent of the riparian vegetative cover. Approximately 20 to 42 percent of the streambanks are covered in native sedge/rush vegetation (primarily the point bars) and up to 26 percent of the streambank area is bare soil (PWI, 1994a). A current plant species list including hypothesized, original woody riparian vegetation for the Lower Red River Meadow is provided in Appendix A.

Very little rainfall occurs during the summer months in the lower meadow (3 to 8 inches or 8 to 20 cm) and surface water levels often drop up to 5 feet (1.5 meters) from the top of bank and below the soil-gravel interface in the riparian corridor. Capillary rise in these coarser textured subsurface materials is limited, reducing the amount of soil moisture in the rooting zone. Reductions in plant available water may be the major limiting factor preventing the natural recruitment or reestablishment of the native riparian vegetation, despite the removal of grazing activities from the RRWMA in 1993. Also, seed sources are unavailable to support natural recruitment since the original woody riparian corridor has long since been eliminated (RME, 1995; BPA, 1996; Brunsfeld et al., 1996).

Aquatic Habitat Features

POOL/RIFFLE HABITAT. Riffle areas characterized by clean gravel/cobble substrate of suitable size and cool temperatures provide high quality habitat for spawning adult salmonids and developing embryos. As fry emerge from their redds (nests), proximity to low-velocity cover and consistent food supply increases their first year survival rate [Independent Scientific Group (ISG), 1996]. Deep, clear pools with clean substrate and overhanging vegetation provide high quality cover, resting, and feeding habitat for anadromous and resident fish.

Optimum pool frequency, indicative of an undisturbed channel of similar wetted width to the Lower Red River, is 14 to 23 pools per mile (1.6 kilometers) (USDA Forest Service, 1995; NWPPC, 1994). A reconnaissance-level survey (PWI, 1994a) reported pool numbers ranging from six on the RRWMA to zero on the Gibler Ranch, with a total of 10 in the entire 4.4-mile (7.1-kilometer) stretch of stream within the lower meadow. The existing pools are of poor quality, lacking overhead and submerged cover. Pool substrate is generally characterized by either a layer of fine sediment or embedded gravels/cobbles (PWI, 1994a).

Optimum pool to riffle ratio equals 60:40 (USDA Forest Service, 1992). The channel in the lower meadow is essentially a series of riffles and riffle-like runs/glides. The highest pool to riffle ratio (26:74) exists on the Ketchum Ranch. At the reconnaissance-level survey (PWI, 1994a), the residual pools depths ranged from 3.4 to 3.8 feet (1.0 to 1.2 meters) (Table 3.2).

STREAMBANKS. Stable undercut banks, overhanging vegetation, and dense and diverse riparian plant communities are features found in a healthy, undisturbed stream ecosystem. Undercut banks and overhanging vegetation provide cover and shade for fish whereas leaf, litter, and twig fall from riparian plants contribute nutrients for aquatic insects consumed by fish. These features are essentially nonexistent throughout the lower meadow (PWI, 1994a) (Table 3.2).

INSTREAM COVER. Instream cover is defined as large woody debris, boulders, and instream vegetation that can deflect flows, trap sediment, develop scour pools, contribute to aquatic food webs, and add diverse and complex habitat (ISG, 1996). These features are found in limited quantities on all land parcels in the lower meadow (Table 3.2). The boulders on the RRWMA were brought in from off-site and placed along one outside bend in a previous attempt at bank stabilization.

WATER QUALITY. Red River and many of its tributaries are listed per Section 303(d) of the

Table 3.2 Fish habitat features associated with Lower Red River Meadow in 1994. Data was collected during a reconnaissance level survey and are presented by land parcel (adapted from PWI, 1994a; BPA, 1996).

HABITAT FEATURE	LAND PARCEL			
	Gibler Ranch	RRWMA	Johnson Ranch	Ketchum Ranch
POOLS				
Number	0	6	1	3
Pool/Riffle Ratio *(feet of pool habitat/feet of riffle habitat)*	0:100	17:83	14:76	26:74
Average Residual Depth *(feet)*	N/A	3.4	3.5	3.8
STREAMBANKS				
Undercut (*percent of bank length)*	0	0.7	0	0
Overhanging Vegetation *(percent of bank length)*	0	0.4	0	0
Riparian Shrubs *(percent cover)*	0	0	0	2
INSTREAM COVER				
Large Woody Debris *(number of pieces)*	0	1	0	0
Boulders *(number)*	0	19	1	1
Instream Vegetation *(percent cover)*	< 1	< 1	< 1	< 1

Clean Water Act as Water Quality Limited Streams (WQLS), having sediment as the pollutant of concern. The Red River watershed has experienced the largest change in historic sediment transport regimes of the 14 major watersheds in the SFC subbasin. Consequently, current sediment yield in the watershed is the highest in the subbasin, 24 percent above natural base conditions (USDA Forest Service, 1998). An overabundance of fine sediment deposition degrades fish habitat by filling in pools and interstitial spaces in the gravel beds used for spawning. Elevated suspended sediment levels can impair sight feeding ability and delay migration of fish.

Summer water temperatures in the Lower Red River vary annually depending on stream flows and weather conditions. Commonly, water temperatures exceed ranges desirable for salmonid spawning, < 60°F (< 15.6°C), and rearing, < 65°F (< 18.3°C) (based on ISG, 1996). During July and August of 1994, thermographs recorded temperatures greater than 72°F (< 22°C) 40 percent of the time (PWI, 1994b). These suboptimal temperature conditions are due in part to the wide surface water widths, shallow depths, and lack of deep pools and overhanging vegetation.

Fish Populations

Historically, the Red River supported relatively abundant numbers and diverse populations of anadromous and resident fish species (Table 3.3). Although many of the historical fish species are still present in the Red River they are generally found in low numbers (Appendix B). The depressed population levels are due in part to the habitat and water quality degradation in the watershed (BPA, 1996; USDA Forest Service, 1998).

Table 3.3. A sample of the diversity of fish species found within the Red River watershed (BPA, 1996).

Common Name	Scientific Name
Chinook salmon	*Oncorhynchus tshawytscha*
Steelhead/Rainbow trout	*Oncorhynchus mykiss*
Westslope cutthroat trout	*Oncorhynchus clarki lewsi*
Bull trout	*Salvelinus confluentus*
Mountain whitefish	*Prosopium williamsoni*
Brook trout	*Salvelinus fontinalis*
Mountain sucker	*Catostomus platyrhynchus*
Longnose dace	*Rhinichthys cataractae*
Speckled dace	*Rhinichthys osculus*
Pacific lamprey	*Lampetra tridentata*
Sculpin	*Cottus spp.*

CHINOOK SALMON. The Harpster Dam built in 1910 on the SFC River and the Lewiston Dam built in 1927 on the Clearwater River essentially eliminated all runs of wild spring chinook into the SFC subbasin. Currently, all spring chinook populations found in the SFC subbasin, including Red River, are hatchery-bred and therefore, not listed as threatened under the Endangered Species Act (ESA) as part of the Snake River ecologically significant unit (ESU). However, the spring chinook within the subbasin are considered a species of special concern by the State of Idaho and a sensitive species by US Forest Service, Region 1 (Idaho, Washington, Oregon, and Montana).

An aggressive, hatchery-supplementation program has helped to establish naturally spawning spring chinook salmon in the SFC subbasin including Red River. Nonetheless, this species continues to decline in number and is considered at high risk of extinction (USDA Forest Service, 1998).

STEELHEAD TROUT. Steelhead trout in the SFC subbasin are part of the Snake River ESU of west coast steelhead, listed by the National Marine Fisheries Service (NMFS) as threatened under the ESA in September 1997. Native steelhead were effectively blocked from the SFC subbasin by the construction and operation of the Harpster dam. After removal of the dam, steelhead from North Fork Clearwater (Dworshak) stock and steelhead collected at Lewiston Dam were reintroduced in Red River and other SFC tributaries (US Forest Service, 1998).

Currently, steelhead have a wide distribution in the Red River watershed but are found generally in low numbers with some limited areas of higher densities. The project reach is an important part of the steelhead migration corridor but is currently in a degraded condition. Very few steelhead utilize the lower meadow reach (Appendix B) since suitable spawning and rearing habitat occurs in upstream reaches and tributaries.

BULL TROUT. Bull trout in the SFC subbasin are part of the Columbia River ESU listed as threatened by the US Fish and Wildlife Service (USFWS) under the ESA in July 1998. Bull trout habitat requirements include stable and complex stream channels, instream woody debris, overhanging banks, and cobble/gravel substrate free of fines. Temperature is a critical habitat feature for the bull trout; they prefer water temperatures < 15^{o}C (59^{o}F) and therefore, are generally found in the coldest stream reaches.

The mainstem Red River is an important migratory corridor and rearing area for subadult and adult bull trout. As part of the mainstem Red River, the lower meadow reach of the Red River serves primarily as a migratory corridor for all life stages of bull trout; however, the area provides sub-optimal habitat conditions due to lack of pool habitat and woody debris, reduced channel complexity, and elevated stream temperatures. Only one bull trout has been observed in annual snorkeling surveys in the entire lower meadow between 1986 and 1998 (Appendix B).

WESTSLOPE CUTTHROAT TROUT. Westslope cutthroat trout are listed as a sensitive on Region 1, US Forest Service, and a species of special concern in the State of Idaho. Current distribution of westslope cutthroat in the SFC subbasin is similar to the historical distribution; however, remaining population numbers have declined (USDA Forest Service, 1998).

Westslope cutthroat trout are found in cold and nutrient-poor waters. Clean substrate of adequate size composition is an important habitat feature critical to the survival of eggs, fry, and juveniles. Most cutthroat are found in the Red River's upper reaches and smaller, remote tributaries where fishing access is limited and habitat is undisturbed. Elevated summer water temperatures, high flows during spring runoff, and increased suspended sediment load restrict migration of cutthroat in the lower reaches of Red River. Cutthroat are found in low numbers in the lower meadow and current project area (Appendix A).

Wildlife

The Lower Red River Meadow is home to a number of game and non-game species. Elk *(Cervus elaphus)*, moose *(Alces alces)*, and white-tailed deer *(Odocoileus virginianus)* graze in the meadow and use the adjacent forested area as calving and fawning habitat. During the spring, as many as 200 elk and 40 cow and calf pairs can be seen in the meadow of the RRWMA.

The wetter areas in the meadow attract Canadian geese *(Branta canadensis)*, mallards *(Anas platyrhynchos)*, wood ducks *(Aix sponsa)*, and other waterfowl and shorebirds. Blue herons (*Ardea herodias*) sandhill cranes (*Grus canadensis*), and osprey (*Pandion haliaetus*) migrate through the area. Red-tailed hawks (*Buteo jamaicensis*), northern goshawks (*Accipiter gentilis*), and various songbirds have been sighted along the timbered edges and upland portions of the meadow.

3.2 PROJECT INCEPTION

Habitat Potential

The Red River watershed is classified as a "historic stronghold" for spring chinook salmon, steelhead trout, bull trout, and westslope cutthroat trout. Although currently in a degraded condition, this watershed contains a disproportionately high amount of the aquatic potential in the SF Clearwater subbasin (USDA Forest Service, 1998).

The upper and lower Red River meadows are two of only five sites within the entire Red River drainage characterized by low-gradients and possessing the potential for high quality fish spawning and rearing habitat [Dave Mays, Fisheries Biologist, Nez Perce National Forest (NPNF), personal communication, 1997).

In addition, both the Nez Perce Tribe (NPT) and IDFG recognize the Red River's aquatic potential as a major spring chinook and steelhead production stream. The Clearwater River Subbasin Salmon and Steelhead Production Plan (NPT and IDFG, 1990) recommends several activities to improve degraded conditions in the Red River drainage including acquiring private lands to protect significant anadromous fish habitat and to implement habitat improvement projects.

Collaborative Purchase and Vision

When the Little Ponderosa Ranch, one of the four parcels in the lower meadow, came up for sale in 1993, BPA, IDFG, Rocky Mountain Elk Foundation, Trout Unlimited, National Fish and Wildlife Foundation, and the US Forest Service recognized a unique opportunity to protect and restore fish and wildlife habitat. The combination of existing and potential fish and wildlife habitat and the structural facilities (ranch house, caretaker's house, and out-buildings) on the property offered an extraordinary setting for a conservation education center as well.

The group moved quickly to collectively purchase the property. The original vision that fueled the collaborative purchase was to protect existing habitat for elk and deer, restore and enhance river/wet meadow habitat for fish and other wildlife, and educate the public about the science of ecological restoration and the wise management of riparian areas and watersheds. Following the purchase, the 314-acre (127-hectare) parcel was deeded to IDFG in an Interagency Memorandum of Agreement (BPA and IDFG, 1994) to manage for habitat restoration and fish and wildlife benefits as the Red River Wildlife Management Area (RRWMA).

In 1994, under the lead of the US Forest Service, a successful proposal for restoration work on the RRWMA was made to BPA as part of the Northwest Power Planning Council's Fish and Wildlife Program (NWPPC, 1994). Restoration work on the RRWMA helps fulfill BPA's obligation to compensate for the loss and degradation of fish and wildlife habitat caused by the construction and operation of the federal hydroelectric dams on the Snake and Columbia rivers.

Project Organization and Coordination

PROJECT SPONSOR. The Idaho County Soil and Water Conservation District (ISWCD) sponsors the Lower Red River Meadow Restoration Project. As the sponsor, the ISWCD contracts directly with BPA, provides a local influence, and administers the overall project. The ISWCD hires technical consultants who are responsible for the design, engineering, revegetation, monitoring, communications, and management of the project.

TECHNICAL ADVISORY COMMITTEE. An interdisciplinary team of experts, The Red River Technical Advisory Committee (TAC), advises the consultants and the ISWCD on government policies and regulations, cultural issues, fisheries and wildlife biology, hydrology, education and public outreach, and land management activities related to the Lower Red River Meadow Restoration Project. The TAC is comprised of representatives from BPA, IDFG, NPNF, NPT, Idaho Department of Health and Welfare's Division of Environmental Quality (DEQ), Idaho Soil Conservation Commission (SCC), and Natural Resources Conservation Service (NRCS).

The TAC reviews restoration designs, construction and planting methods, monitoring plans, and sediment and erosion control techniques. Through this process, the TAC helps the consultant team and ISWCD define the most appropriate stream alignment and cross-section shapes; optimize habitat quantity and quality; mitigate short-term impacts to fish, wildlife, and water quality; and establish suitable monitoring protocols.

The project is carried out as a coordinated team effort between the ISWCD, consultants, and TAC. Hereafter, the term *project team* is used to refer to this group.

COORDINATION WITH USFS. The NPNF fishery/water quality objective for the Red River watershed, as outlined in the Forest Plan (USDA Forest Service, 1987), is to restore the watershed's habitat potential to 90 percent. In 1987, the NPNF estimated the Lower Red River area at 50 percent of its habitat potential.

The NPNF has implemented habitat improvements in both riparian and upland areas of the Red River watershed since 1984. BPA and the NPNF have focused restoration activities on critical riparian habitats within the watershed using bank stabilization techniques, fencing, and vegetative plantings (Baer et al., 1990; Siddall, 1992). Road stabilization is a major component of upland work.

The project team is working closely with the NPNF to achieve overall recovery of the watershed by complementing ongoing watershed-based conservation and restoration activities.

3.3 RESTORATION PLANNING

Pre-Restoration Analyses

Initial planning for the Lower Red River Meadow Restoration Project involved several on-site surveys and assessments of existing conditions, documented in the following reports:

- Stream habitat reconnaissance survey (PWI, 1994a)
- Evaluation of stream temperatures (PWI, 1994b)
- Cultural resources survey (Luttrell, 1995),
- Project restoration design criteria (RME, 1995)
- Analysis of baseline conditions and restoration alternatives (Brunsfeld et al., 1996)
- Pre-project environmental assessment (BPA, 1996)

Based on the above analyses, the project team determined that the existing channel instability and inadequate hydrologic conditions on the RRWMA precluded the use of passive restoration techniques. The team agreed that channel modifications that raise the water table would be required to establish soil moisture conditions necessary to support extensive native riparian plant communities similar to those that existed historically. In addition, alterations to the planform, cross-section, and gradient were deemed vital to achieve long-term stabilization of the incised river channel.

Restoration Design Philosophy

A stream channel in an undisturbed watershed is self-regulating, meaning the channel is in a dynamic rather than static state. A stable channel adjusts its form (i.e., local slopes and velocities, bed material arrangement, channel pattern) in response to natural fluctuations in discharge and sediment in order to maintain a balance between sediment supply and sediment transport (Leopold et al., 1964, Ecosystem Recovery Institute, 1996). In this stable state, termed *dynamic equilibrium*, a meandering stream channel may migrate laterally over time, but will retain its cross-sectional shape. Slow rates of erosion on outside bends are balanced by similar rates of deposition on inside point bars.

Based on these principles, the project team chose a natural channel or soft restoration design philosophy (Figure 3.5). In contrast to a hard engineering philosophy that uses bank-armoring structures to confine a stream into a set configuration, a natural channel design allows the channel to evolve into a stable form over time.

The restoration design for the Lower Red River mimics natural, river/wet meadow ecosystem conditions by restoring the natural physical and biological processes given current watershed inputs, using empirical relationships for natural stream characteristics, hydrodynamic modeling, and specific engineering and revegetation design criteria (see Chapters 4 and 5).

Mission Statement and Objectives

The project team has established the following Mission Statement:

"This demonstration project is designed as a model to restore the Lower Red River Meadow, using a holistic watershed approach, to a naturally functioning wet meadow ecosystem. The project goals are to increase the quality and quantity of fish and wildlife habitat, improve water quality, and promote watershed restoration education."

Figure 3.5 Summary of the design philosophy used in the Lower Red River Meadow Restoration Project.

PRINCIPLES OF A NATURAL CHANNEL OR SOFT RESTORATION DESIGN PHILOSOPHY

★ The stream is returned to a state of dynamic equilibrium, self-sustaining over time *(requiring minimal human intervention in the future)*, by restoring
- ❖ river channel cross-sectional shape, sinuosity, and gradient;
- ❖ hydroperiod in the meadow;
- ❖ groundwater-meadow relationship;
- ❖ sediment transport regime; and
- ❖ high quality and diverse fish habitat.

★ The stream is unconfined by rigid, unnatural bank stabilizing structures.

★ Riparian plant communities provide the natural bank stabilizing force where
- ❖ dense and diverse native plantings accelerate the establishment of native communities;
- ❖ plants are produced from cuttings or seed collected on-site or as near the site as possible;
- ❖ deep and dense root systems increase bank stability, thereby reducing erosion and improving water quality;
- ❖ restoration of the river's hydrologic function improves conditions for natural regeneration of native riparian and wetland plant communities in the future; and
- ❖ improvements to fish habitat include overhanging vegetation, undercut banks, and sources of nutrients and instream woody debris.

To accomplish this mission, the following general objectives have been defined:

1. Restore natural river channel shape, meander pattern, and substrate conditions to enhance the quantity and quality of spawning and rearing habitat for chinook salmon, steelhead trout, bull trout, and other species of fish and aquatic organisms.

2. Restore meadow and riparian plant communities to enhance fish and wildlife habitat, stabilize streambanks, and improve water quality.

3. Promote public and agency awareness and scientific knowledge of watershed restoration principles and techniques.

4. Measure and document progress in satisfying short- and long-term project goals, objectives, and outcomes.

5. Manage and communicate project activities to efficiently accomplish project goals.

Restoration Time Frame

Project planning encompassed nearly two years (1994-1996), resulting in the overall goal or mission statement, restoration philosophy, general objectives, and conceptual restoration design alternatives.

The implementation phases of the project began in June 1996. Restoration of the 1.5 miles (2.4 kilometers) of stream on the RRWMA was divided into four phases with the intent of completing one phase per year, beginning on the upstream end of the property (Phase I) and finishing on the downstream end (Phase IV). By the end of 2000, Phases I through IV will be complete. Phases V through VIII will move restoration work to willing landowners upstream and downstream of the RRWMA.

CHAPTER 4

ENGINEERING AND CONSTRUCTION

Track excavator digs a dry channel named Big Bend. Adding length to the river by creating new meanders and reconnecting historic meanders decreases the stream gradient, slows water velocities, and reduces local streambank and bed erosion rates.

The long-term fish and wildlife habitat improvement and protection goals and the educational vision for the Red River Wildlife Management Area offered a unique opportunity to adopt a natural river engineering approach that would return the Red River into a state of dynamic equilibrium.

The engineering design and construction work restore the natural physical characteristics, including channel cross-sectional shape, sinuosity, gradient, sediment transport regime, and floodplain function. The river is expected to move laterally across the meadow, but retain its cross-section dimensions, maintaining a balance between sediment supply and sediment transport. Soil moisture conditions improve as the channel narrows, surface water elevations increase, and normal flood events are allowed to extend onto the meadow floodplain. Adequate soil moisture conditions are necessary to reestablish and sustain native riparian plant communities once thriving along the river corridor. As the channel evolves toward a stable state and native riparian vegetation matures, erosion rates will decrease, water quality will improve, and diverse and high quality fish and wildlife habitat will develop.

4.1 ENGINEERING DESIGN CRITERIA

The engineering design for channel reconstruction in Phases I and II is based on specific engineering design criteria that facilitate the evolution of natural, river/wet meadow ecosystem processes and functions and thus, a state of dynamic equilibrium.

These specific engineering design criteria were developed using historical information as well as more recent data (Table 4.1). Historic conditions, interpreted from local accounts and 1936 aerial photographs, are used as a design template, recognizing that these exact conditions are unattainable given permanent changes in the watershed. Recent sources of data include baseline condition surveys and analyses (PWI, 1994a; PWI, 1994b; RME, 1994; Luttrell, 1995; BPA, 1996; Brunsfeld et. al., 1996), stream flow/sediment delivery records, empirical relationships for natural stream characteristics, and target fish utilization periods and habitat needs. In addition, the TAC supplied interdisciplinary expertise and input on desired outcomes during the design criteria development process.

4.2 REGULATORY CONSIDERATIONS

In-Channel Work Permits

Because the restoration design involves physical channel modifications, the project is required to obtain the following two permits for all in-channel (below the ordinary high water mark) construction work:

- Nationwide Permit (per Section 404 of the U.S. Clean Water Act) issued by the US Army Corps of Engineers (USACE)
- Stream Alteration Permit (per Section 42-3805 of the Idaho State Code) issued by the Idaho Department of Water Resources (IDWR).

All in-channel work is conducted during July 1st – August 15th according to conditions and restrictions set forth within the permits. The construction window is established to comply with IDFG requirements, minimizing construction-related impacts to spawning, rearing, and migration of anadromous and resident fish. The permits require adherence to general and specific conditions related to the following:

- Stockpiling and placement of temporary and permanent fill.
- Rock and log material selection and placement.
- Woody debris alteration.
- Temporary water diversion structures.
- Refueling and maintenance of heavy equipment.
- Disturbances to native and endangered species.
- Discharge of dredged or fill material.
- Preservation of tribal rights and historic properties.

Water Quality Standards

During construction, the project must observe Idaho State Water Quality Standards. Project related turbidity (a measure of suspended sediment concentration) is not to exceed background turbidity by more than 50 nephelometric turbidity units (NTU) instantaneously or more than 25 NTU for more than ten consecutive days (DEQ, 1996). Project sediment load is not to exceed 150 tons (projected in the NEPA environmental analysis, BPA, 1996).

Best Management Practices

The project implemented several Best Management Practices (BMPs) to comply with water quality standards and stream alteration permit conditions during the 1996 and 1997 field seasons.

BMPs are designed to minimize or otherwise avoid the likelihood of soil, disturbed by construction, becoming suspended into the live stream channel. Examples of BMPs used in the 1996 and 1997 field seasons include timing of in-channel work, digging dry channels, placing temporary fill material in protected locations, filtering suspended fines through depressional wetland areas, and limiting stream crossings with heavy equipment (Table 4.2). Continuous turbidity monitoring allows the construction team to modify BMPs quickly should a particular practice prove inadequate.

Table 4.1. Engineering design criteria used for the restoration of Phase I and Phase II of the Red River flowing through the RRWMA, Lower Red River Meadow Restoration Project (RME, 1995; BPA, 1996).

Channel Component	Engineering Design Criteria
FISH HABITAT	The project targets spring chinook salmon, steelhead trout, bull trout, and westslope cutthroat trout. Stream channel design incorporates utilization periods (e.g., spawning, emergence, rearing, and juvenile outmigration) for target species with stream flows, channel geomorphology, and habitat features.
RIPARIAN VEGETATION	Engineering design creates surface water levels and bank features that facilitate adequate soil moisture within the root zone of riparian vegetation during the growing season. Pre-project observations documented the soil saturation zone within 24 to 30 inches (61 to 76 cm) above low flow water level. Top of banks will be designed, when applicable, at a height less than 36 inches (91 cm) above anticipated low flow water levels.
SINUOSITY RATIO	Engineering design restores sinuosity ratios similar to 1936 conditions where feasible and applicable (Table 3.1).
CHANNEL GRADIENT	Engineering design restores channel gradients similar to 1936 conditions where feasible and applicable (Table 3.1).
MEANDER PATTERN	Natural meander patterns are complex successions of irregular and compound bends which do not conform to traditional indices and theoretical models used for defining them. Therefore, the new meander pattern design uses gradient, sinuosity ratio, radius of curvature, channel diversity, and habitat diversity criteria instead of following a pre-defined relationship. New meander bends will lengthen stream channel, raise low flow water surface elevations, and reduce shear forces. Meander bend design uses a radius of curvature equal to 2-3 channel widths.
HYDRAULIC GEOMETRY	Estimate characteristic stream flows and hydraulic geometry using historic stream gaging measurement records from the Clearwater River Basin. Incorporate current channel shaping flows and low flows that influence the survival of salmonid populations into stream stabilization designs. Design discharges include seven-day average low flow (19 cfs), average annual flow (136 cfs), and average flood flow (846 cfs).
CROSS SECTION SHAPE	Three separate cross-sectional shapes for straight reaches, transition reaches, and bend reaches conform to variations in natural channel morphology. Design cross-sections in straight reaches as simple trapezoid shape. Design transition reaches to transfer water from straight reaches into the bend reaches and design bend reaches to initiate scour pool development along the outside edge. Develop shapes that allow above average flood flows to spread out over the floodplain and maintain low flow water surface elevation to within 36 inches (91 cm) of top of bank.
SEDIMENT TRANSPORT	Channel design creates a stable stream in the long-term where slow rates of erosion on the outside bends are matched by similar rates of deposition on point bars, maintaining a balance between sediment supply and sediment transport. The river bed experiences neither net aggradation nor net degradation and the channel maintains its cross-sectional shape as it naturally migrates laterally across the valley floor. Channel design facilitates substrate conditions suitable for spawning in potential redd sites and minimizes the accumulation of fine sediments. Over time, the river will increase its capacity to naturally sort particles to create diverse substrate conditions across bars, pools, riffles, and other geomorphic features expected in a healthy river system. Best management practices (BMPs) maintain turbidity induced by construction activities at levels less than 50 NTU above background to avoid any negative impacts to fisheries resources.
CHANNEL AND HABITAT DIVERSITY	Design increases channel feature diversity to create a variety of habitat types used during specific life cycle stages of the target fish species. Additional ecosystem features evolve or are enhanced to provide habitat for other fish, waterfowl, and wildlife. These features include acute bends, gradual bends, floodplains, terraces, pools, riffles, runs, glides, side channels, off-channel ponds, islands, new channel wetlands, flooded abandoned oxbows or meander bends, and tributary mouths.
INSTREAM COVER	Designs include features that create cover and shade for target species including large woody debris, undercut banks, overhanging vegetation, submerged vegetation, water surface turbulence, deep pools, boulders, and gravel and cobble substrate. Many of these features will develop over time.

Table 4.2. Descriptions of BMPs and implemented during the 1996 (Phase I) and 1997 (Phase II) field seasons on the RRWMA, Lower Red River Meadow Restoration Project.

Best Management Practice	Description
TIMING	All in-channel work, below the ordinary high water mark, is limited to a six week period, July 1st – August 15th to minimize construction-related impacts to spawning, rearing, and migration of anadromous and resident fish. Compliance with this construction window is required by the IDFG and is established within the guidelines of the 404 Stream Alteration Permit issued jointly by the US Army Corps of Engineers (USACE) and the Idaho State Department of Water Resources (DWR).
SOIL PLUGS/DRY CHANNELS	Excavation takes place in dry channels, whenever feasible, by maintaining a soil plug between excavation activities and the live stream channel. Soil plugs remain at the up- and downstream boundaries until ready to connect the new stream reach with the live channel.
SEQUENCING	Sequential staging of excavation, water diversion, and removal of soil plugs facilitates the settling of sands and filtering of fines prior to complete diversion of water into new channel alignment.
PUMPING/SETTLING	Turbid water is pumped through vegetated historic channels or wetland swales whenever feasible to filter fines before water travels back to live stream channel. Pumps are equipped with fish screens on intake hoses. Constructed pools in new channel bends and enhanced pool areas in historic bends are used to settle sands.
EQUIPMENT REFUELING AND MAINTENANCE	Refueling and servicing of all vehicles and construction equipment is performed outside of riparian areas or $\geq$ 300 feet from the live stream channel.
STREAM CHANNEL CROSSINGS	Stream channel crossings with heavy equipment are minimized; crossings are located in shallow, straight reaches with gravel/cobble substrate and no previous history of redds. Equipment time required in live stream channel is also minimized.
FISH TRANSFER	As the former channel is dewatered, a fisheries consultant or IDFG staff supervises the electrofishing procedure to safely transfer remaining fish from former channel to new channel. Harm to fish is reduced by using the minimum required pulse rate and width and minimizing handling time. A Fish Collection Permit is obtained from IDFG. Species and numbers of fish transferred are documented.
DISTURBED SOILS	All disturbed soil areas are treated with erosion control measures such as seeding, biostabilizing, and/or placement of erosion control matting. Equipment traffic during wet weather or within wet zones is minimized.
FILL PLACEMENT	Excavated material is stockpiled at a distance from the live stream channel and above the ordinary high water mark to reduce the risk of high water inundation. All excavated material not used as backfill in former channel is placed in upland areas.
MONITORING	Automatic, continuous turbidity sensors are located above and below construction activities and record baseline and project-related turbidity (NTU) every 10 minutes. Manual sediment samples are collected to estimate suspended sediment concentration (mg/L) and sediment load (tons) attributed to project activities.
ADAPTIVE MANAGEMENT	Continuous turbidity monitoring provides immediate feedback to the construction team relative to sediment and erosion control measure performance, allowing timely modifications to procedures when necessary.
FEEDBACK LOOP	A feedback loop with DEQ is maintained to ensure compliance with water quality standards. Should an instantaneous measurement exceed 50 NTU above background, the incident is documented, DEQ is informed, and a BMP response is formulated to bring turbidity levels back into compliance.

4.3 RESTORATION FEATURES AND EXPECTED OUTCOMES

Several months prior to each field season, a stream alteration permit application is submitted to the USACE and the IDWR for review. As part of the application package, drawings and text are used to explain channel and floodplain modifications, riparian revegetation design (discussed in Chapter 5), and sediment and erosion control measures associated with the proposed restoration.

Pre-existing features on the RRWMA are illustrated in Figure 4.1. Channel realignment and restoration features planned for Phases I and II are illustrated in Figure 4.2 and explained below.

Meander Pattern

The new meander pattern is designed as a complex and irregular succession of bends. Constructing new meanders and reconnecting historic channel sections (Figure 4.2) lengthens the stream channel. Increasing the length of the stream decreases the gradient and increases the sinuosity ratio. Ultimately, the new meander pattern is expected to initiate and maintain the following conditions:

- Raise low flow water surface elevation to within 36 inches (91 cm) of top of bank.
- Restore floodplain function, increasing the frequency and duration of the meadow hydroperiod.
- Reduce channel bed downcutting, streambank erosion rates, and associated elevated suspended sediment levels.
- Reestablish sediment transport regime to within the range of natural conditions, improving substrate quality.
- Reconnect tributary flows to low flow water elevations in main channel.
- Create and sustain backwater and side channels.

Channel Cross Sectional Shapes

Cross-sectional shapes are designed using estimated characteristic stream flows, natural channel shapes, fish habitat criteria, and hydraulic geometry relationships. Channel cross-sectional shapes differ depending on type of reach – straight, transition, or bend (Figure 4.3).

Design options for outside bank of bend reaches include a 1:1 slope, a vertical cut bank, or a vertical cut bank/terrace combination. Point bars opposite the outside banks are designed with 2 percent slopes (Figure 4.4).

The modified channel shapes are expected to:

- Initiate scour pool development along outer bank of bend reaches.
- Create deep pools and develops pool-riffle sequences.
- Decrease channel width/depth ratio.
- Adjust to and withstand natural stream discharges.
- Allow above average stream flows to spread out onto floodplain dissipating energy, flooding wetlands, and recharging the aquifer.
- Allow point bar inundation at lower water elevations, reducing erosive energy on outside bends.
- Facilitate the deposition of relatively fine materials on inside bends, resulting in point bar aggradation and narrowing of channel width.
- Maintain low flow water surface elevation to within 36 inches (91 cm) of top of bank.
- Aid in the reducing summer water temperatures.

Water Surface Elevation

Rock sills (Figure 4.5) are used as grade control structures to raise ground and surface water elevations, reduce erosional forces, and provide soil moisture conditions suitable for native riparian vegetation. For each sill, approximately 20 boulders ranging from 36 inches (91 cm) in diameter are placed across the channel in an arc shape. The apex of the arc is positioned on the upstream side. Several boulders are anchored into each streambank (Figure 4.6).

Rock sills are designed to develop the following habitat features and functions:

- Elevate low flow surface water elevation to within 36 inches (91 cm) of top of bank.

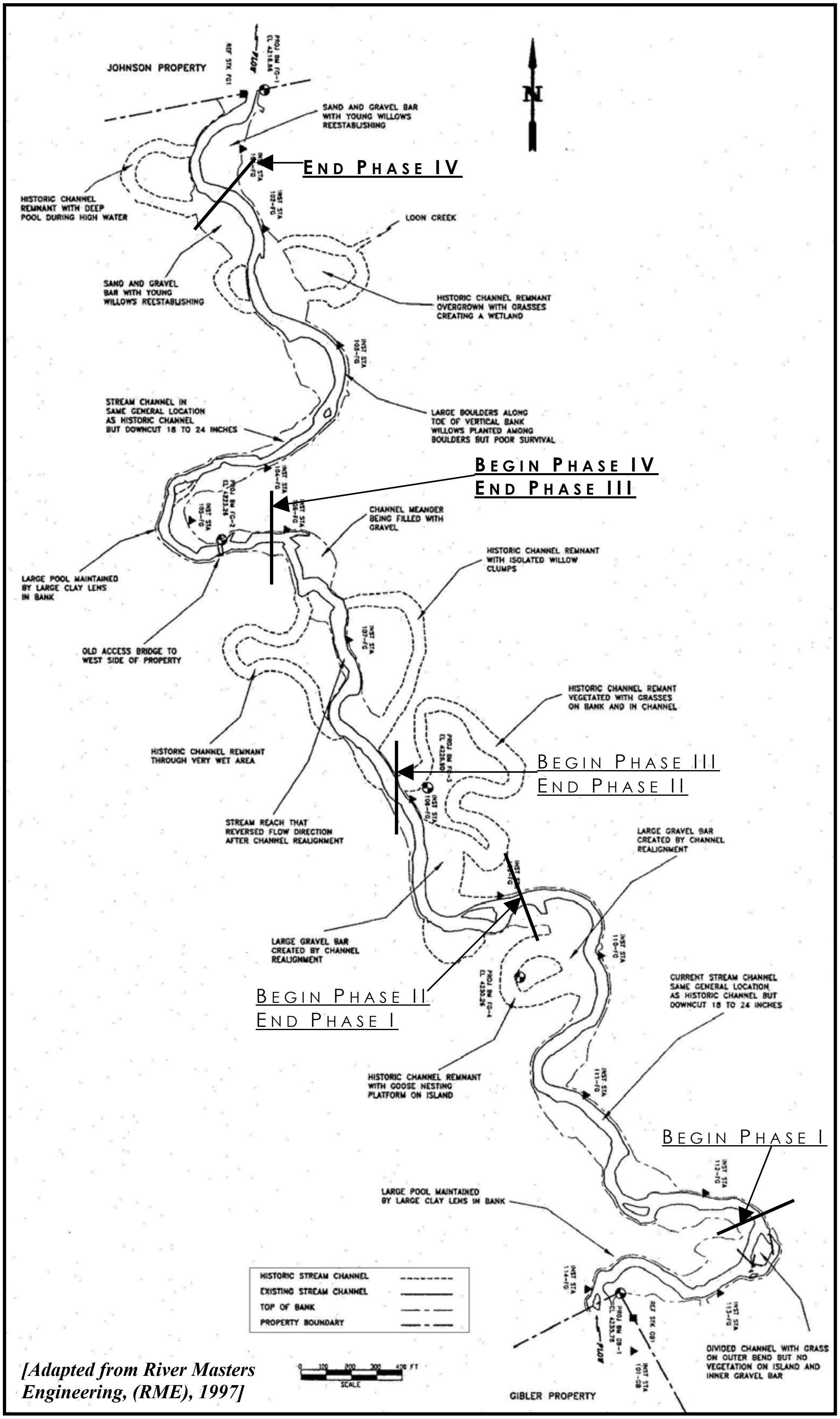


Figure 4.1. Pre-existing features and planned restoration phases on the Red River Wildlife Management Area, Lower Red River Meadow Restoration Project.

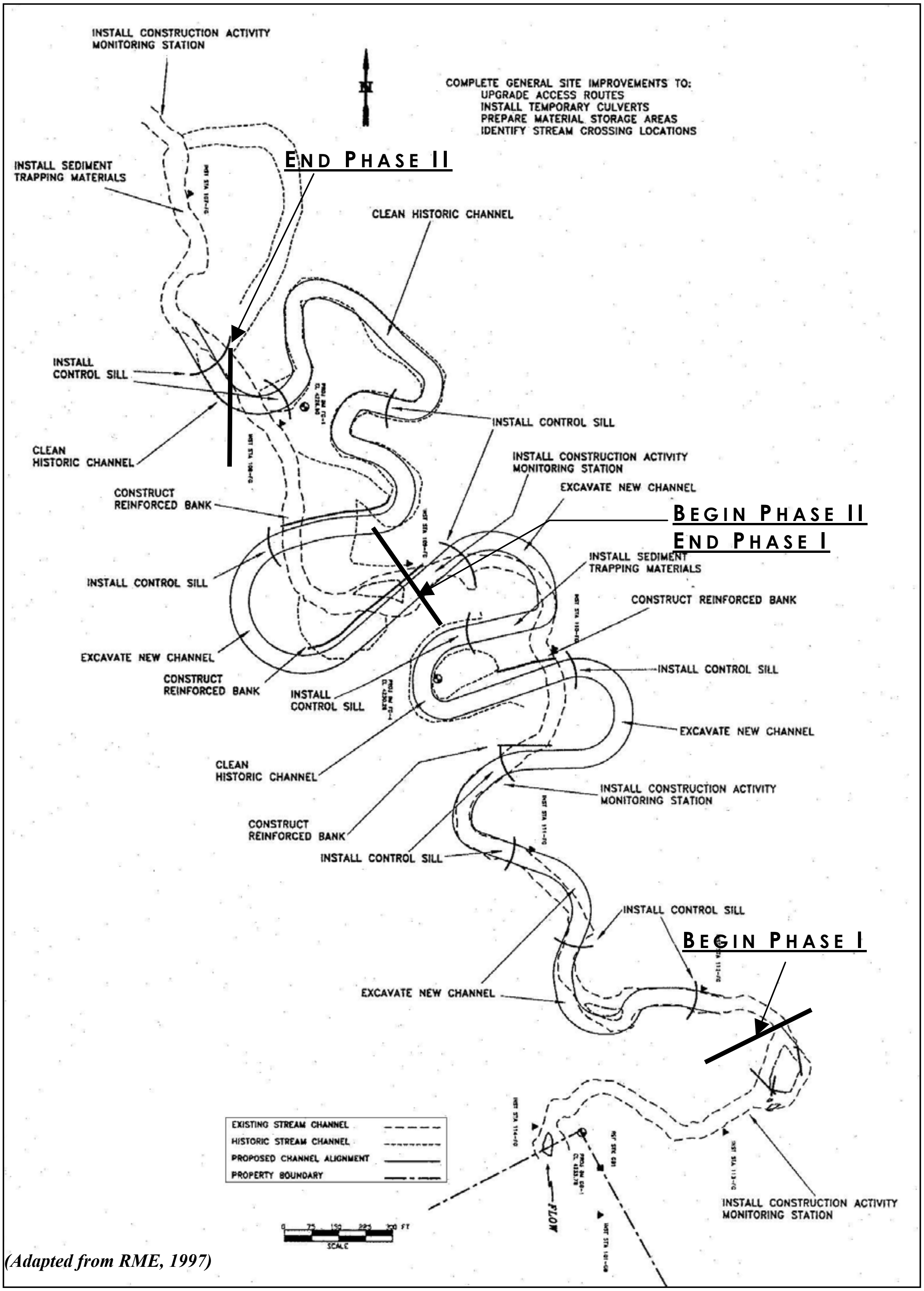


Figure 4.2. Overall engineering modifications planned for Phases I and II on the Red River Wildlife Management Area, Lower Red River Meadow Restoration Project.

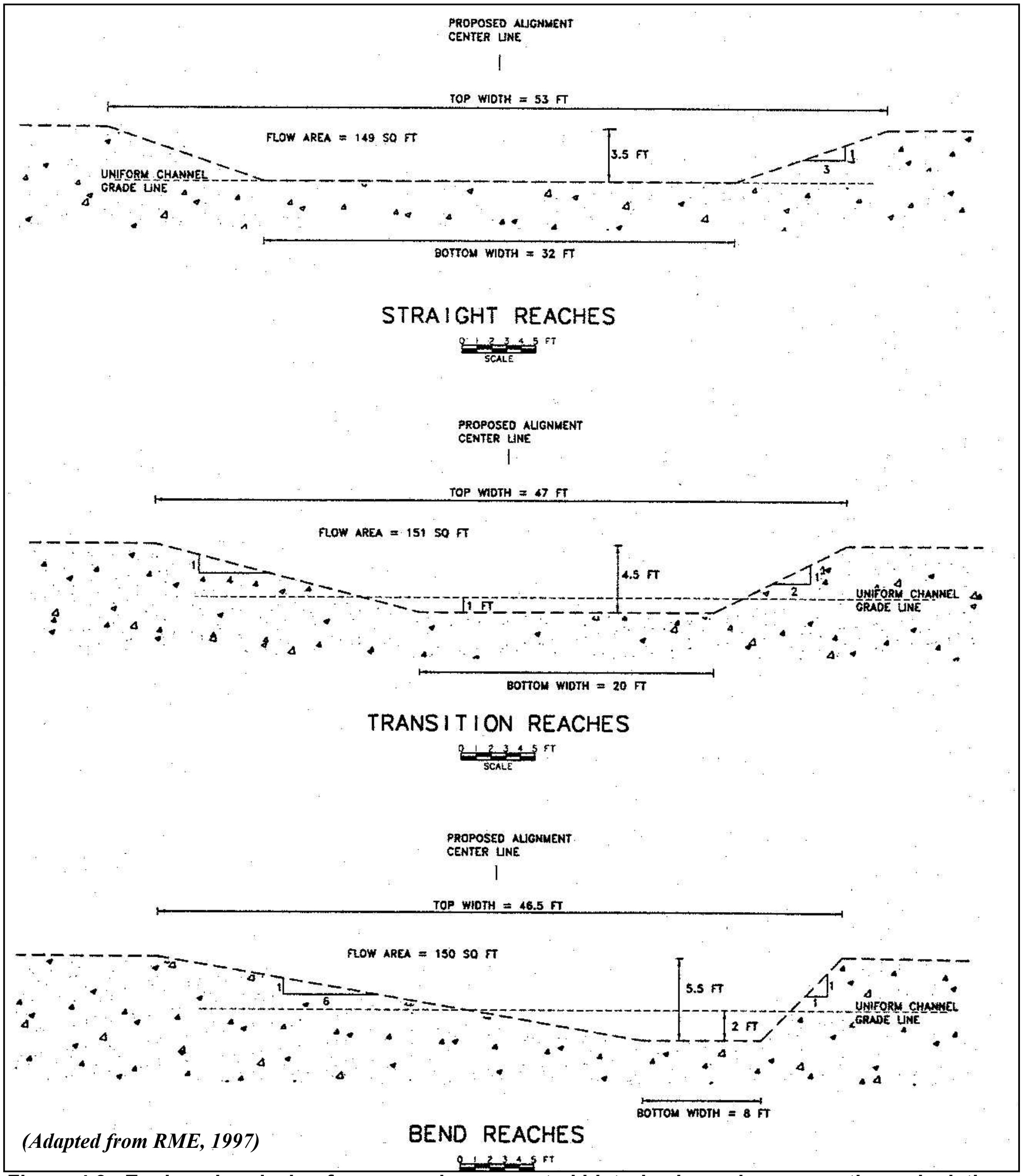


Figure 4.3. Engineering design for new and reconnected historic channel cross-sections, depicting differences in shapes for straight, transition, and bend reaches in Phases I and II, Lower Red River Meadow Restoration Project.

- Collect gravels and cobbles on upstream side, increasing channel bed elevation.
- Create plunge pool directly below on downstream side.
- Develop a pool tail-out (riffle) downstream of plunge pool.
- Maintain tributary connections with river channel at low flow.
- Reconnect or create backwater areas and side channels.

Channel Dewatering, Diversion Structures, and Fish Transfer

Once reconstruction is complete, water is diverted into the new channel in a sequential manner by using temporary diversion

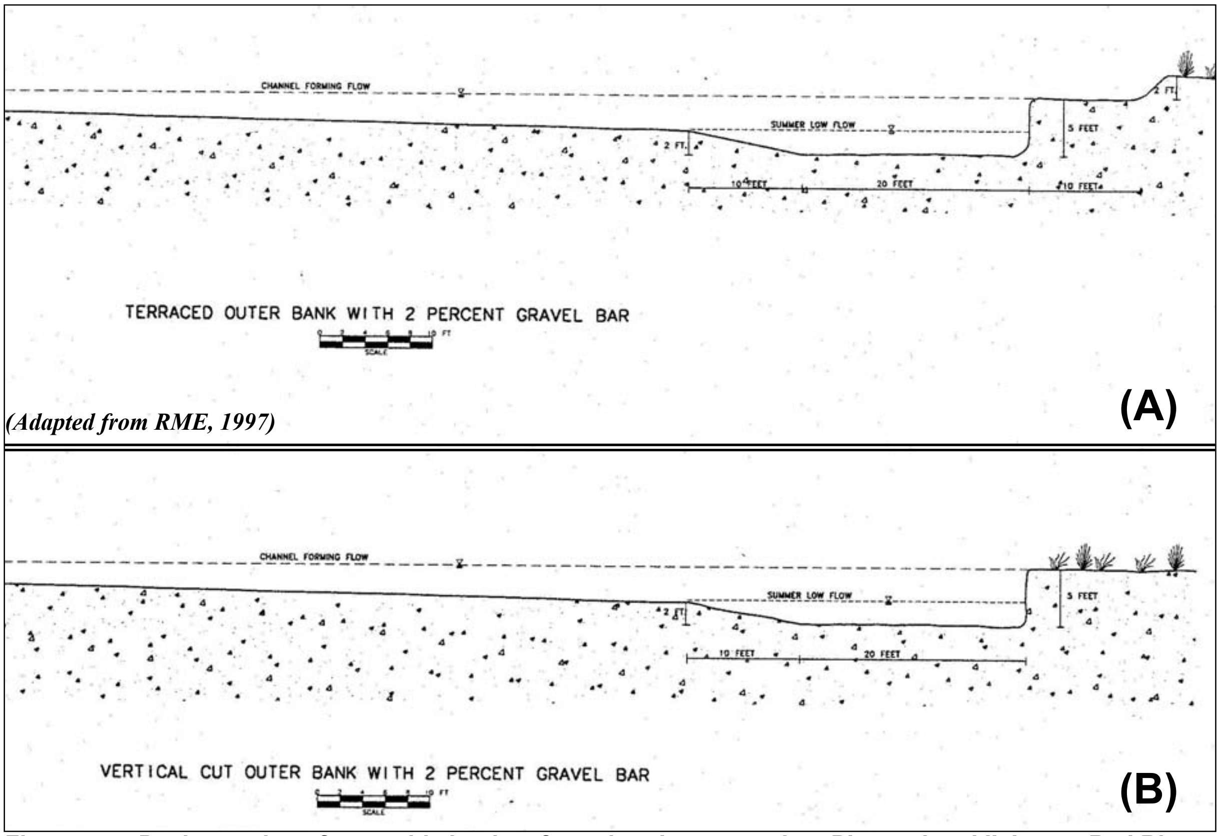


Figure 4.4. Design options for outside banks of new bend construction, Phases I and II, Lower Red River Meadow Restoration Project: (A) vertical cut bank/terrace combination or (B) vertical cut bank. Both cross-sectional shapes are designed with 2 percent gravel bars on the inside of the bend.

Figure 4.5. Finished rock grade control structure in Phase I, Lower Red River Meadow Restoration Project. Water flow is from left to right in this photograph.

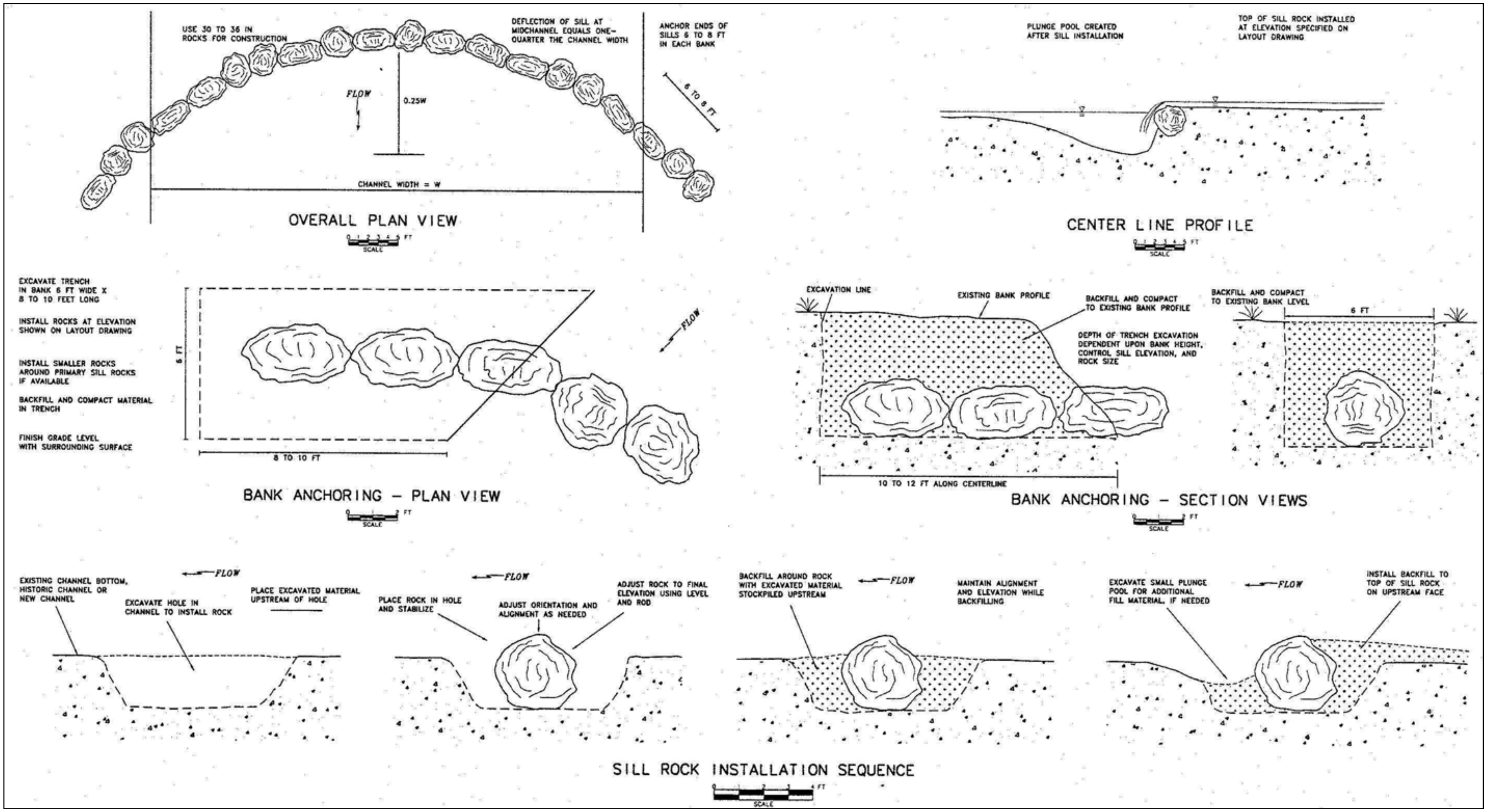


Figure 4.6 Rock control sill specifications and installation details for Phases I and II of the Lower Red River Meadow Restoration Project (adapted from RME, 1997).

structures. The diversion structures are placed across the width of the existing channel to alter the stream course and divert live water into the new channel. Water bladders and concrete highway barriers were used as diversion structures in 1996 and 1997, respectively. Diverting water into the new channel section, dewatering the former channel section, and transferring fish from the former channel takes place over several days. The following procedure was used in Phases I and II:

- Track excavator positions water bladders or concrete highway barriers across the width of the upstream end of the channel section to be abandoned, slowly diverting water flow into new channel and blocking flow from former channel area.
- Geotextile sediment control fabric is placed on upstream side of the diversion structures.
- Remaining water is allowed to freely flow out the downstream end of the channel to be abandoned; large fish leave the channel at this time.
- Residual water is pumped from the former channel onto the adjacent floodplain using a tractor-mounted pump equipped with fish screen on the intake hose.
- As channel is dewatered, a fisheries consultant supervises electrofishing procedure to safely transfer remaining fish from former channel to new channel; harm to fish is minimized by using the minimum required pulse rate and width and minimizing handling time.
- Downstream diversion structure is installed as fish are being transferred, preventing fish migration back into former channel.

Reinforced Banks

Before temporary diversion structures are removed, reinforced banks (Figure 4.7) are installed at the upstream end of the former channel and the entire former channel is backfilled with soil and gravel excavated from new or historic channel sections.

Reinforced banks consist of layers of rocks and logs with soil and gravel fill and are designed to prevent recapture of the old channel alignment. These structures extend the entire width of the former channel and are anchored into each bank (Figure 4.8). The reinforced bank is completely buried with backfill material except near the water's edge. Where log ends meet the water's edge, localized lateral scour pools, beneficial as fish habitat, are expected to develop.

Figure 4.7. Track excavators install a log and rock reinforced bank.

Streambank Protection Structures

A variety of natural structures including plunging bank logs, deflector logs, root wads, and log/root wad combinations (Figure 4.9) were designed to protect streambanks and provide diverse fish habitat on the outside bends in Phases I and II. These stream protection structures are expected to provide the following:

- Log/root wad structures deflect water flow and reduce erosive energy.
- Localized scour around log/root wad structures creates small pools for fish habitat.
- Log/root wad structures provide shade and cover for fish.

4.4 ENGINEERING ACCOMPLISHMENTS

Phases I and II engineering accomplishments (Figure 4.10) included reconnecting two historic channel meanders (Goose Island Bend and Historic S-Curve Loops), constructing two new meanders (Big Bend and Giant Bend), and accentuating three existing outside bends

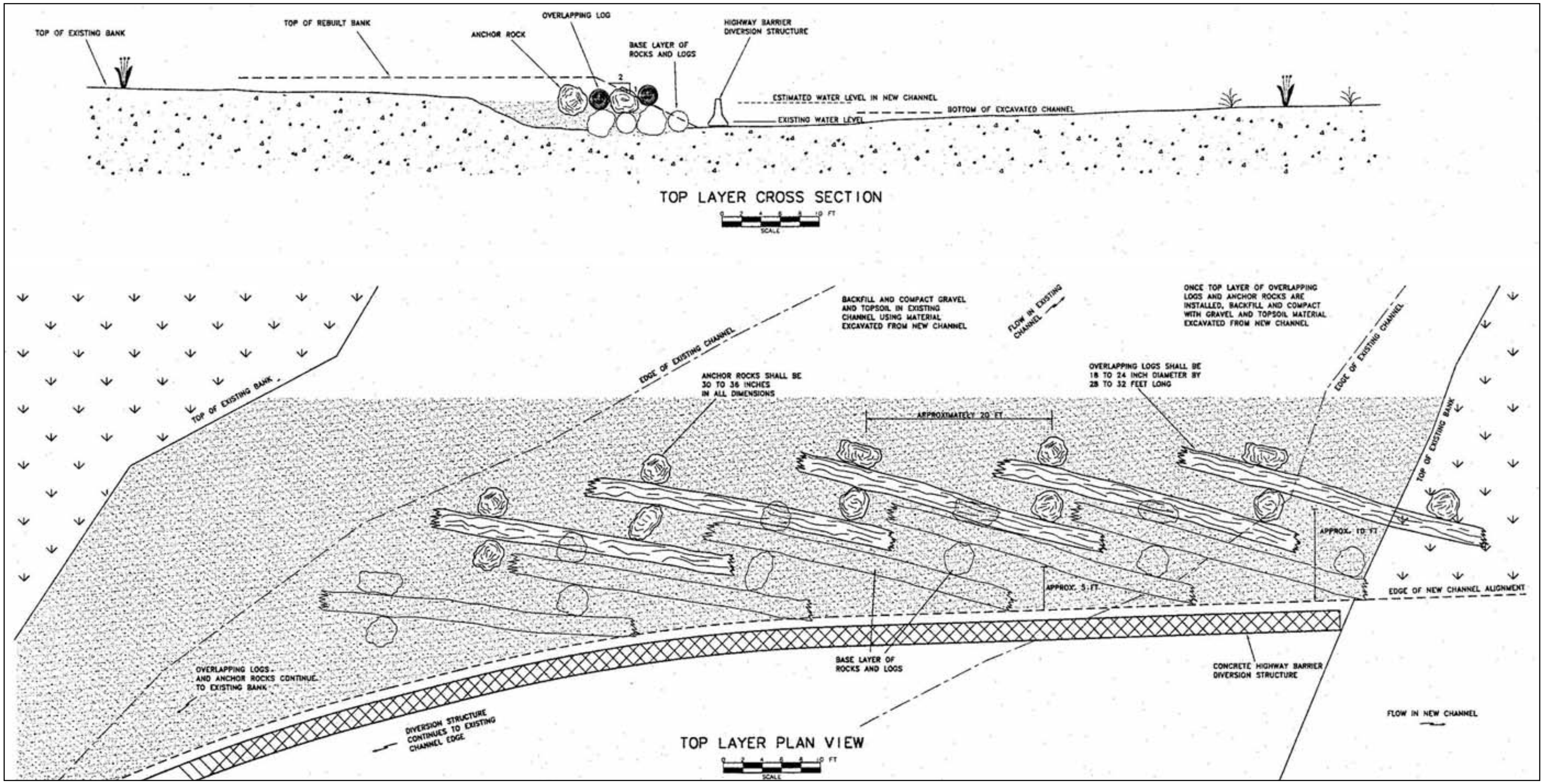


Figure 4.8. Phases I and II, Lower Red River Meadow Restoration Project: Reinforced bank details illustrating placement of top layer logs and rocks over bottom layer that has been backfilled with gravel and excavated soil materials (adapted from RME, 1997).

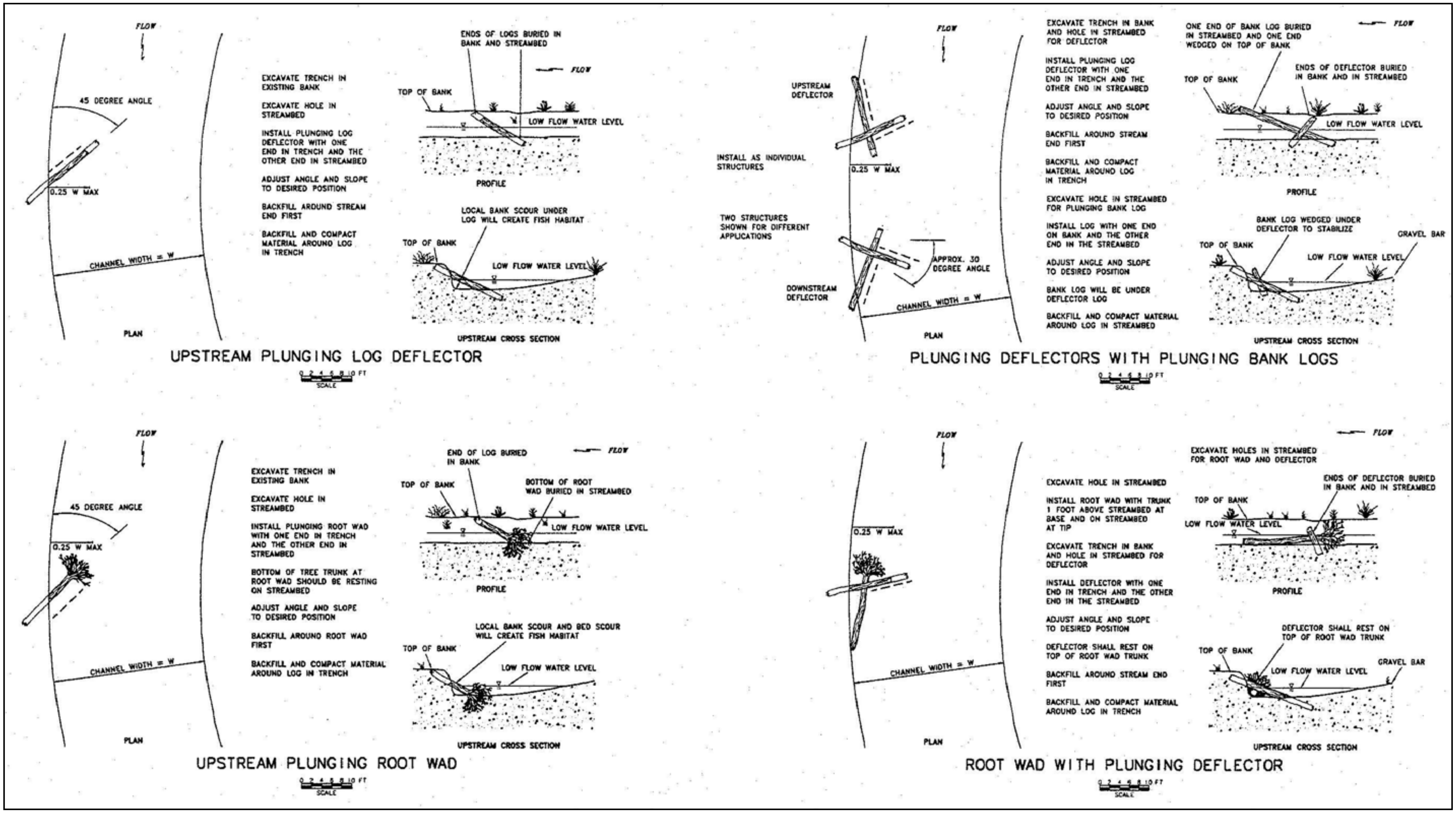


Figure 4.9. Installation details of a variety of streambank protection and fish habitat structures designed for placement on outside bends in Phases I and II, Lower Red River Meadow Restoration Project (adapted from RME, 1997).

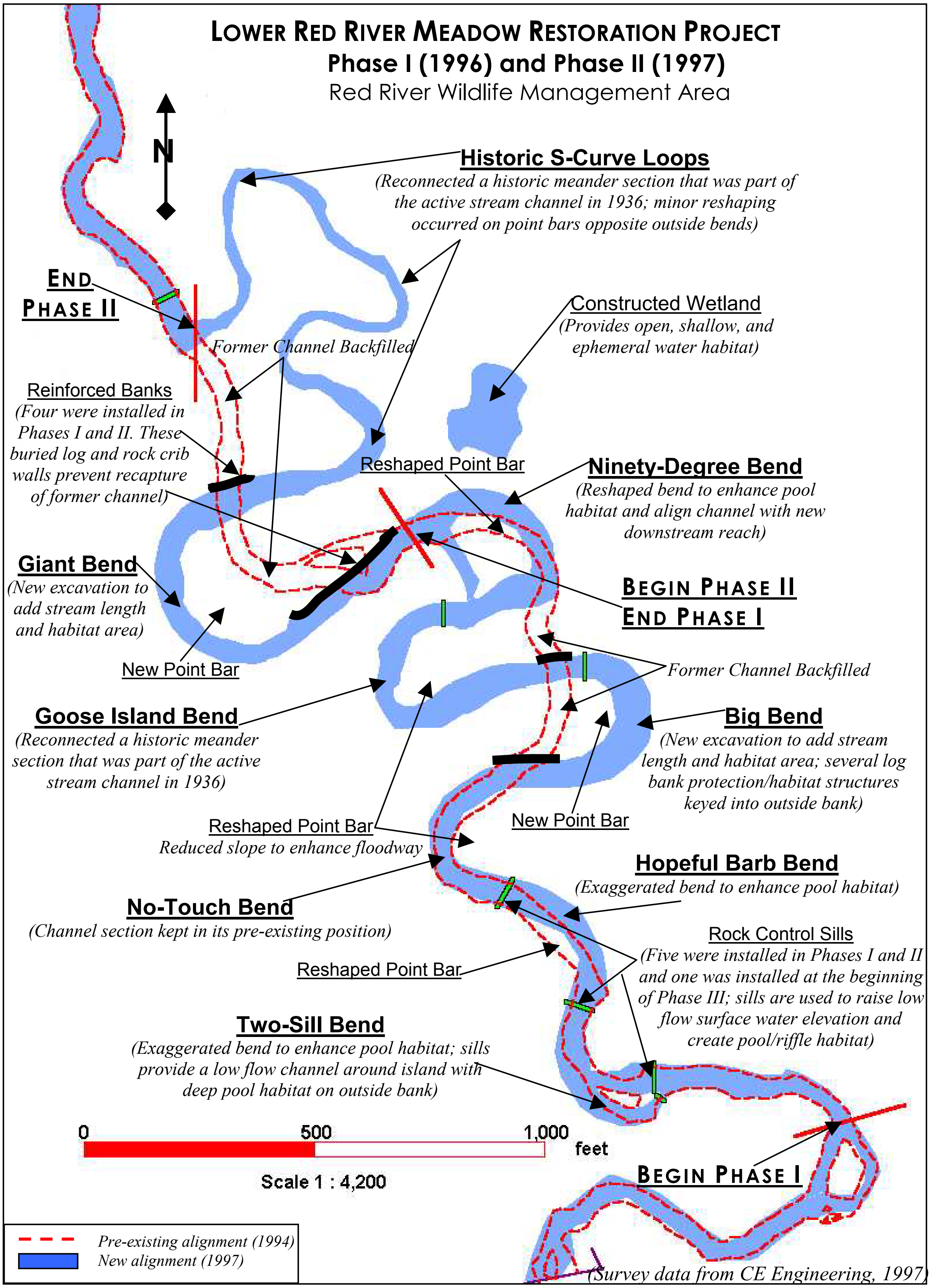


Figure 4.10. As-built channel alignment and major features in Phases I and II of the Lower Red River Meadow Restoration (drawing courtesy of TerraGraphics, Environmental Engineering, Inc., 1999).

(Two-Sill Bend, Hopeful Bend, and Ninety-Degree Bend). Due to these changes in channel alignment, the channel length on the entire RRWMA increased by 3,060 feet (933 meters), channel gradient decreased by 25 percent, and sinuosity increased from 1.7 to 2.3. As the channel stabilizes with time, reduced stream bank and bed erosion rates and improved water quality are expected.

Channel cross-sectional shapes and point bars were modified or created to maintain deep pool habitat during low flows, convey average annual flows within the channel, and dissipate flood flows onto the floodplain. Six rock grade control structures were installed to raise low flow surface water and groundwater elevations, and ultimately, to provide soil moisture conditions conducive to the establishment and sustainability of native riparian plant communities (Figure 4.10). Increases in both surface water and groundwater elevations are expected to reconnect tributary mouths, backwater channels, and other off-channel rearing habitat to the main channel.

A pond/wetland area, approximately 200 feet by 125 feet (61 meters by 38 meters) was constructed in Phase II to provide additional shallow and open water habitat for waterfowl and other wetland dependent species. Several log habitat structures were keyed into the outside streambanks of Big Bend and Hopeful Barb Bend. On the entire RRWMA, fish habitat area increased by approximately 35 percent. In Phases I and II alone, fish habitat area increased by nearly 95 percent. Both the number of pool/riffle sequences and residual pool depths increased by approximately 60 percent.

Engineering accomplishments during the first two years of this multi-phase project represent the initial steps toward the evolution of the Lower Red River into a state of dynamic equilibrium. The performance and short-term success of the restoration design and implementation of Phases I and II is evaluated in the project's monitoring program discussed in detail in Chapter 6.

CHAPTER 5

REVEGETATION

Planting willows in reconstructed channel (left). Willow growth on same bank, one year later (right).

The engineering and revegetation components of the project have a synergistic effect. Lengthening the stream and installing grade control structures result in increased surface water elevations as well as floodplain inundation frequency and duration. In turn, these improved hydrologic conditions provide soil moisture necessary for the establishment and sustainability of the native riparian plant communities. Overhanging vegetation, deep and fibrous root systems, and dense and diverse plant communities within the riparian zone provide bank stabilization, cover and shade for fish, nutrients for aquatic insects, instream woody debris, and habitat for wildlife.

Species comprising the once prevalent native plant communities were hypothesized using on-site and adjacent land surveys, current published literature, historical data and photographs, and local accounts of historical conditions. Active replanting is necessary since elimination of the original woody riparian corridor, both on the project site and upstream as well, reduced seed sources to numbers incapable of supporting natural recruitment. As plantings become established and soil moisture conditions are restored, natural recruitment and regeneration are expected.

5.1 REVEGETATION DESIGN CRITERIA

The revegetation design criteria for the Lower Red River Restoration Project were developed to meet project goals, philosophy, and objectives. A number of factors were considered including plant selection, fish and wildlife habitat features, riparian zone width, hydrology, planting density and plant size, streamflow velocity, sinuosity ratio, bank slope, soil stratigraphy, construction travel corridors, disturbed construction areas, and browsing/grazing control (Table 5.1).

Sustainable riparian communities are dependent on the evolution of natural physical properties restored by the engineering features (Chapter 4). Therefore, several revegetation criteria are associated with restored channel and floodplain function. For example, elevating the low flow water level to within 36 inches (91 cm) of top of bank and reconnecting the floodplain to the stream channel increases frequency and duration of the meadow hydroperiod, providing suitable soil moisture conditions for the native plant communities. Planting locations based on soil moisture requirements for particular species are based on this expected rise in low flow water surface elevations and enhanced hydroperiod.

Table 5.1. Revegetation design criteria used for Phases I and II of the Lower Red River Meadow Restoration Project. Criteria are based on Carlson et al. (1991) and recommendations of the Red River TAC and Wildlife Habitat Institute (WHI).

Restoration Factor	Revegetation Design Criteria
PLANT SELECTION	All plant species will be native to site. Herbaceous wetland/riparian plant seed will be collected on site, grown in a commercial greenhouse, then out-planted on site. Dormant willow pole cuttings will be collected on nearby sites having similar elevation, temperature, and precipitation conditions. Plantings should be as diverse in composition as the major components of the target plant community. Seed and cutting selection will be subject to availability.
FISH HABITAT	Established riparian plantings will create and enhance fish habitat conditions. As the height and density of streambank vegetation increases, overhanging vegetation will provide shade and cover. Deep and dense root systems will stabilize banks and allow the development of undercut banks. Woody riparian vegetation will supply a source of instream woody debris. Increased stream shading and stabilized streambanks will result in reduced summer water temperature, turbidity, and suspended sediment levels, thereby improving overall water quality.
WILDLIFE HABITAT	Diverse and dense plantings in the riparian corridor and expanded wetland and open water areas will provide nesting, foraging, and cover habitat for a variety of waterfowl, upland birds, and terrestrial mammals.
RIPARIAN ZONE WIDTH	Riparian zone will extend a minimum of 20 feet (6.1 m) from streambank edge of mean low water level on straight reaches and inside bends or from top of bank on vertical cut banks.
HYDROLOGY	Engineering features will raise surface water elevations to within 36 inches (91 cm) of top of bank at low flows, enhancing soil moisture conditions for riparian community establishment. Streamside plantings will be situated to anticipate this change in low flow water surface level. Planting design will accommodate the preferred hydrologic conditions for each species.
PLANTING DENSITY/PLANT SIZE	High density, mass plantings provide greater erosion control and plant survival and are more likely to withstand browsing, trampling, or other physical damage. Design and specifications will incorporate the largest stock size available and the greatest quantities possible within budgetary constraints.
STREAMFLOW VELOCITY	Newly vegetated banks need protection from high-water/high velocity events. In general, fully revegetated streambanks can tolerate flows up to 8 feet per second (2.4 m/s) for short periods and up to 5 feet per second (1.5 m/s) for extended periods. Revegetation design will assume that post-reconstruction streamflow velocities will not exceed these parameters. This assumption is based on the restoration of the channel gradient to 1936 conditions, ranging from 0.17 percent to 0.23 percent. Success of streambank revegetation increases when channel gradients are below 1 percent. Greatest success is achieved as gradients approach or fall below 0.1 percent.

Table 5.1 cont. Revegetation design criteria used for Phases I and II of the Lower Red River Meadow Restoration Project. Criteria are based on Carlson et al. (1991) and recommendations of the Red River TAC and WHI.

Restoration Factor	Revegetation Design Criteria
SINUOSITY RATIO	Streambank revegetation success is greatest when stream curve radius to stream width ratio exceeds 10. Planned channel reconstruction design will conform to this guideline.
BANK SLOPE	In general, revegetation is most successful on streambanks with slopes of 3:1 or flatter. Steeper slopes are subject to greater water velocities and stronger erosive forces and will undermine revegetation efforts. Revegetation design, specifications, and planting time periods will consider reconstructed bank slope within the various channel reaches to optimize revegetation success.
SOIL STRATIGRAPHY	Fluvial materials are characteristically deposited in non-uniform layers of varying soil textures. Fine-textured streambank soils are more resistant to erosive forces than coarse-textured soils. A subsurface gravel layer subject to erosive forces can be scoured out causing the collapse of the upper bank. Plant species selection and planting densities will be determined by the soil stratigraphy and erosive potential of various stream reaches; faster-growing plants and higher planting densities will target the reaches with the highest erosion potentials. Whenever feasible topsoil removed during excavation will be stockpiled and replaced prior to planting.
CONSTRUCTION TRAVEL CORRIDORS	Fragile, moist riparian soils are susceptible soil compaction from heavy equipment and vehicle traffic. Soil compaction negatively affects riparian plant establishment and may encourage the recruitment of invasive and aggressive exotic communities. Travel corridors will be planned to minimize compaction and soil damage in the riparian corridor. Whenever feasible, heavy equipment with tracks, rather than rubber tires, and 4- or 6-wheeled all-terrain vehicles (ATVs) will be used. After construction is complete, travel corridors will be ripped to a depth of 2 feet (61 cm), graded, and seeded with a native grass mix. A policy will be established for construction shut down during rain events and for future access and maintenance.
DISTURBED CONSTRUCTION AREAS	All areas of exposed soil, as a result of construction activities, will be sown with an erosion control seed mix and planted with native herbaceous and woody vegetation according to the approved planting design and specifications. Prior to planting, coconut fiber erosion control matting will be positioned on sites having the greatest erosion potential (e.g. reinforced banks).
BROWSING/GRAZING CONTROL	The property perimeter fence will be maintained to protect new plantings from cattle trespass. Revegetative success monitoring and construction of temporary wildlife exclosures will be used to evaluate browsing impacts to riparian plantings. Deer/elk repellent may be used as necessary. Temporary wildlife exclosures are designed to establish islands of dense, woody vegetation that will spread and serve as a seed source facilitating future natural recruitment.

5.2 PLANTING DESIGN AND METHODOLOGY

Planting Design

EXPECTED TARGET COMMUNITY. A riparian classification system has yet to be developed for the north-central region of Idaho. Therefore, the expected target communities for the Lower Red River Meadow were hypothesized using the following sources:

- Community descriptions in similar ecosystems of nearby regions (Padget et al., 1989; Brunsfeld and Johnson, 1995; Hansen et al., 1995),
- On-site surveys of native vegetation in an established exclosure at the downstream end of the meadow and existing plant communities within the riparian/meadow areas of the RRWMA (Brunsfeld, 1994), and
- Historical photographs and local accounts.

Brunsfeld (1994) hypothesized that willows comprised the major component of the original woody riparian community, primarily Drummond willow *(Salix drummondiana)*, Geyer willow *(S. geyeriana)*, and Booth willow *(S. boothii)*. Other woody species included Pacific willow *(S. lasiandra)*, sandbar willow *(S. exigua),* red-osier dogwood *(Cornus stolonifera)*, thinleaf alder (*Alnus incana*), and bearberry honeysuckle *(Lonicera involucrata)* (Appendix A).

Many of the native herbaceous species existing today comprised the original associated understory including a variety of sedges *(Carex spp.)*, rushes *(Juncus spp.)*, bulrushes *(Scirpus spp.)*, and grasses that thrive in moist to wet soils. However, coverage and diversity of these species have been reduced by grazing, haying, and channel alterations that have resulted in decreased soil moisture conditions and invasion of exotic pasture grasses (Brunsfeld, 1994).

On wetter sites near the stream channel and in off-channel topographic depressions, communities of Drummond willow/beaked sedge *(S. drummondiana*/*Carex rostrata*) or Geyer willow/beaked sedge *(S. geyeriana/C. rostrata)* are expected to develop. On drier sites at the outside edges of the riparian zone and slightly drier meadow areas, communities of willows/bluejoint reedgrass *(Salix spp./Calamagrostis canadensis)* or willows/tufted hairgrass *(Salix spp./Deschampsia cespitosa)* are expected to develop.

PLANTING SCHEMES. An overview of the planting scheme for Phases I and II is provided in Figure 5.1. Riparian communities vary according to the three general stream reach types – straight, outside bend, or inside bend (Figure 5.2). The planting plan specifies Drummond willow, Geyer willow, Pacific willow, and sandbar willow. Subsequent field surveys determined that Booth willow was not part of the original dominant willow community in this geographic location and therefore was eliminated from the planting scheme. Other native woody species used in the design include red-osier dogwood, thinleaf alder, serviceberry (*Amelanchier alnifolia*), Douglas hawthorn *(Crataegus douglasii)*, quaking aspen *(Populus tremuloides)*, and bearberry honeysuckle. Although serviceberry, hawthorn, and quaking aspen are absent from the list of hypothesized original woody vegetation, these native species exist in limited numbers on or very near the project site, and therefore, were included in the planting design. Native herbaceous species include dagger-leaf rush (*Juncus ensifolius)*, Coville's rush (*J. covillei)*, Colorado rush (*J. confusus),* small-fruited bulrush (*Scirpus microcarpus*), small-winged sedge (*C. microptera*), lens sedge (*C. lenticularis*), and beaked sedge (*C. rostrata*).

Planting Methodology

WOODY PLANT SPECIES. Willow species are planted as dormant pole cuttings during the late spring and summer. Other woody shrubs are planted as seedling plugs. Since native sources are unavailable on site, the willow pole cuttings are collected as close to the project site as possible. Geyer willow are collected in Elk City, Idaho; Drummond willow near Elk River, Idaho; and Pacific and sandbar willow are collected from the St. Joe or upper Clearwater rivers. Seed sources for alder, dogwood, aspen, honeysuckle, serviceberry, and hawthorn are found on the project site and up- or downstream.

Willow pole cuttings are collected, prepared, and cooler-stored during February and March prior to each field season. Pole cuttings are removed from the cooler and soaked in water for three days at ambient outside temperatures to initiate bud and root growth just prior to spring/summer planting. Project personnel experimented with a few red-osier dogwood pole cuttings (as opposed to seedlings grown in the greenhouse) in 1997. The red-osier dogwood pole cuttings received similar treatment as the willow plus horizontal scoring of the bark and soaking in a root-promoting acid solution (idolebutyric acid).

Seeds of thinleaf alder, red-osier dogwood, serviceberry, and other native woody species are collected in the summer/fall, cleaned and prepared for storage during the winter, and then planted in a commercial greenhouse in late winter and early spring (February through May). Seedlings can be planted in the fall or the following spring. Seedlings held over until the following spring are moved into a cooler during peak dormancy (January) and stored until ready to plant.

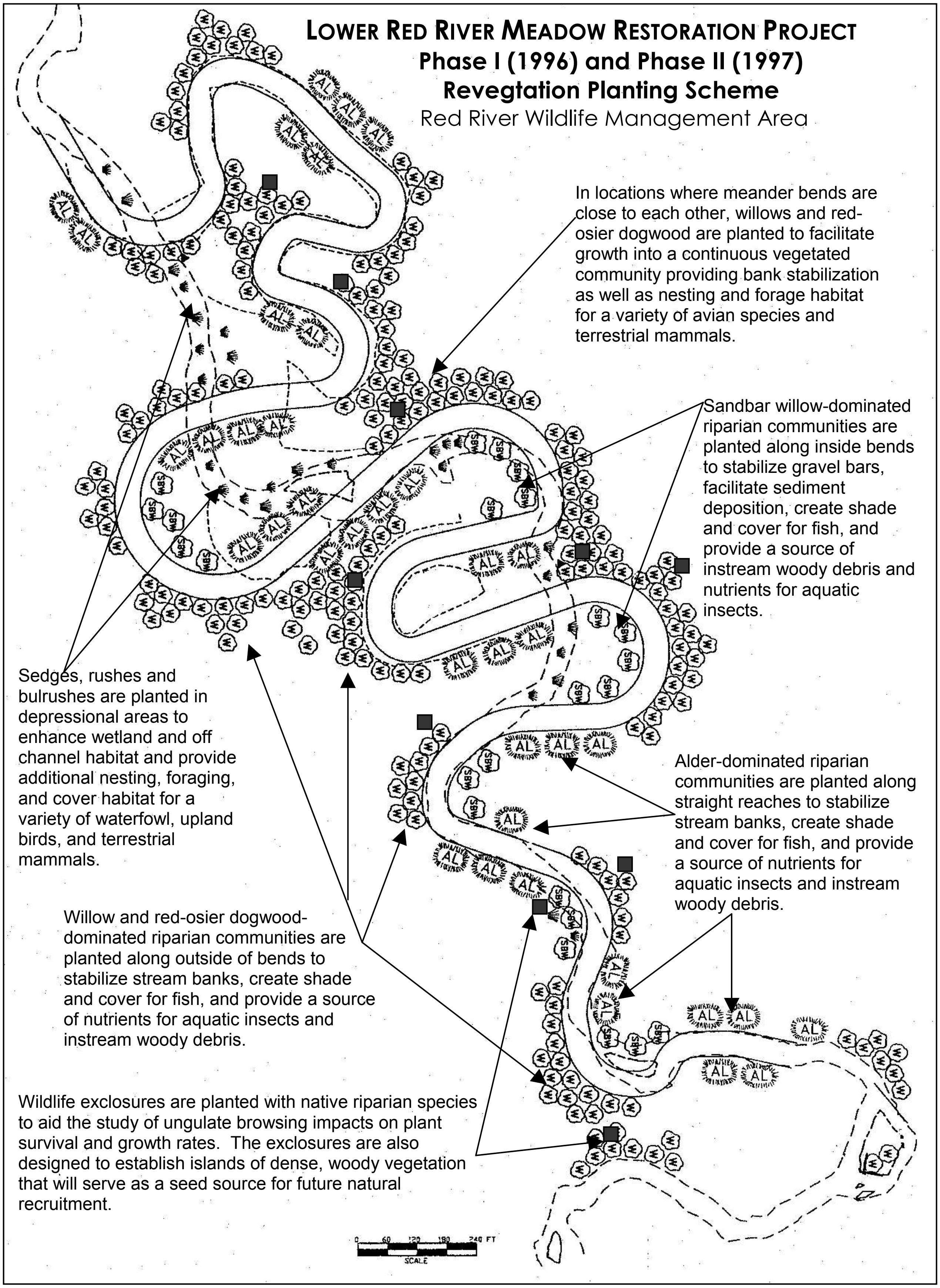


Figure 5.1. Locations and expected functions of native riparian plant communities in Phases I and II of the Lower Red River Meadow Restoration Project (adapted from RME, 1997).

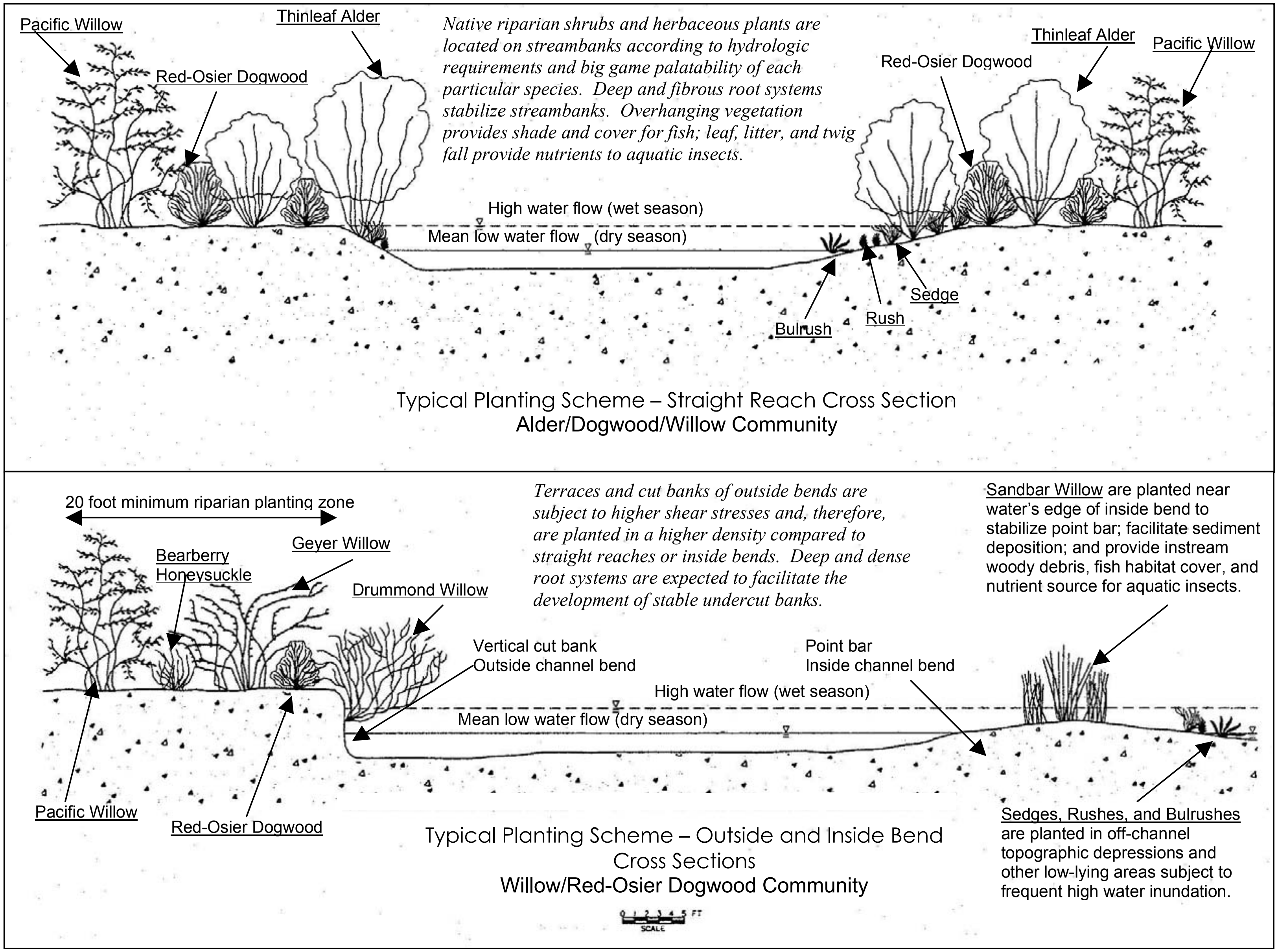


Figure 5.2. Typical planting schemes for straight and bend reaches in the Lower Red River Meadow. All plants are native to the meadow and seed is collected on site whenever feasible. Species selection is subject to seed/cutting availability (adapted from RME, 1997).

In general, planting locations are selected according to the hydrologic requirements and big game palatability of a particular species. For example, species requiring the highest amount of soil moisture, such as Drummond willow and sandbar willow, are placed closest to the water's edge. Drummond willow and red-osier dogwood, highly palatable to big game animals, are planted into the outside cut banks where access is difficult. Less palatable species, such as thinleaf alder, are used in the more game-accessible straight reaches.

Pacific and Geyer willow poles, ranging 5 to 10 feet (1.5 to 3 meters) in length, are placed within 20 feet (6.1 meters) of the water's edge on top of the bank or terraces. The terraces of outside bends are planted with a higher density planting [approximately 6 to 10 feet (1.8 to 3 meters) on center] compared to straight reaches or inside bends. A tree planting auger is used to drill 4 inch (10 cm) diameter holes as deep as possible to ensure the cuttings reach the mid-summer water table. An auger-resistant layer of river rock/gravel occurs at varying depths throughout the meadow. Holes drilled less than 32 inches (81 cm) deep, due to this impenetrable gravel layer, are abandoned and refilled. A single pole is placed in each hole and, if possible, pressed further into the ground. The holes are then backfilled with existing soil to achieve good soil-to-stem contact.

Drummond and sandbar willow poles, ranging from 4 to 8 feet (1.2 to 2.4 meters) in length, are placed at or near the water's edge. Depending on soil conditions, both Drummond and sandbar willow can either be inserted by hand or placed in a drilled hole. Drummond willow poles are pushed into the soil to reach the mid-summer water table, usually at a 45-degree angle to the vertical bank along outside bends (Figure 5.3). Drummond willow poles are planted in high densities, often exceeding 1 foot (30 cm) on center, to accelerate the development of stable streambanks, shade and cover, and reduced water temperatures.

Sandbar willow poles are pushed into the soil at or below the waterline on the inside bend point bars. In areas where soil conditions preclude hand placement, a hole is drilled to a 2-foot (61-cm) depth, the pole cutting is placed, and the hole is then backfilled to achieve good soil-to-stem contact. Sandbar willow poles are planted in point bar areas to facilitate long-term sediment deposition and subsequent decrease in channel width.

Thinleaf alder seedlings are planted along straight reaches and red-osier dogwood are interspersed amongst the Drummond willow along the outside bend cut banks. Serviceberry seedlings are planted on the top of banks or terraces. Woody seedlings are planted using an auger with a 1.5-inch (3.8-cm) diameter earth bit or hand dibble. The seedling is placed into the hole and then backfilled, using care not to create airspace along the seedling plug and soil interface.

HERBACEOUS PLANT SPECIES. Seeds from dagger-leaf rush, Coville's rush, Colorado rush, small-fruited bulrush, small-winged sedge, lens sedge, and beaked sedge are collected on the project site in August and September. Seedlings are grown in a commercial greenhouse in 10 cubic inch (164 cubic cm) containers the following spring and early summer and delivered to the meadow for planting in August and September.

Herbaceous plants are also placed according to their specific hydrologic and other known habitat requirements. Dagger-leaf rush, Coville's rush, and small-fruited bulrush are planted at or near the water's edge (Figure 5.4). Colorado rush and small-winged sedge are planted in dryer sites on top of the banks or terraces. Lens and beaked sedge are planted into the slumped areas of cut banks (Figure 5.3) and in off-channel water-holding depressions.

The majority of seedlings are planted with a 1.5-inch (3.8-cm) diameter, gas-powered auger/drill; a small percentage is planted with a hand dibble. The herbaceous seedlings are planted in varying densities. The design specifications set the spacing of herbaceous seedlings on approximately 4-foot (1.2-meter) centers, interspersed amongst the woody shrub species. In areas disturbed by construction and more susceptible to erosional forces, such as exposed vertical banks, herbaceous plant densities are increased.

GRASS SEEDING. An erosion control seed mix is sown in newly exposed soil disturbed by construction activities such as reinforced

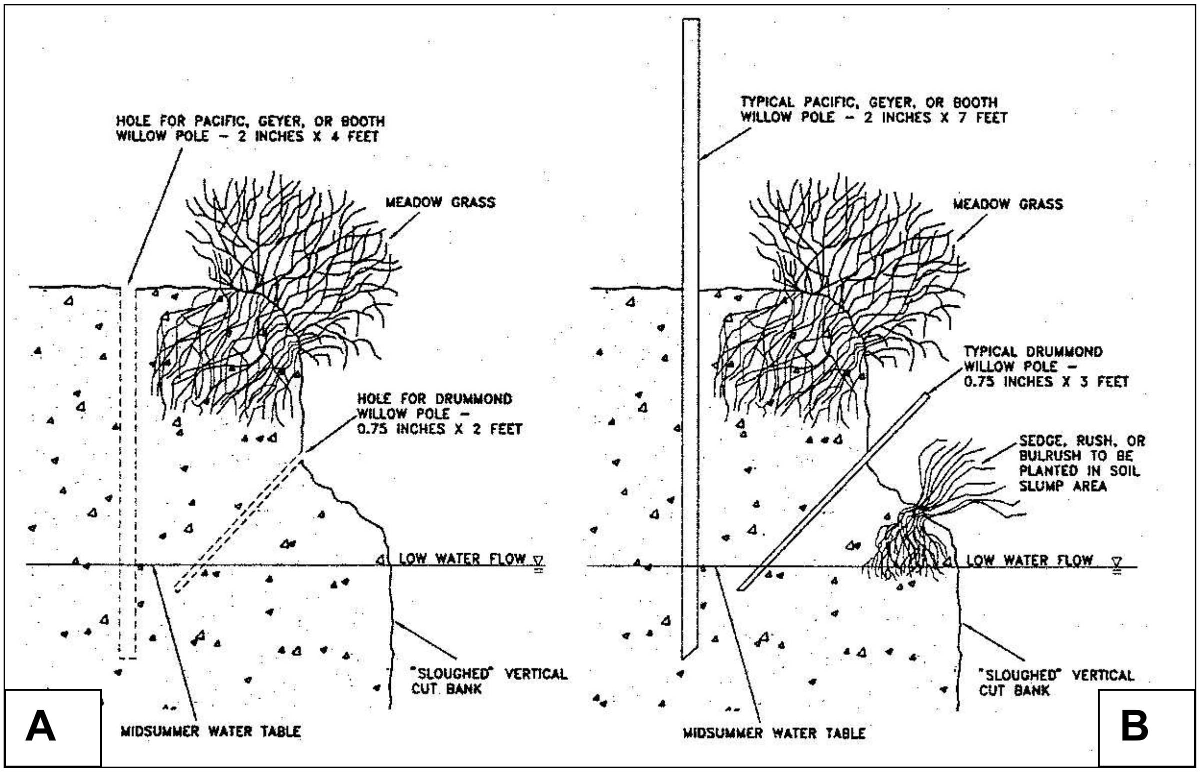


Figure 5.3 Typical planting details for placing dormant willow pole cuttings. Holes are drilled vertically or at a 45-degree angle into the streambank to a depth below the midsummer water table (A). Geyer and Pacific willow poles are planted on top of bank; Drummond willow poles are planted at an angle into the vertical outside bank, and herbaceous wetland plants are placed into soil slump areas (B) (adapted from RME, 1997).

Figure 5.4. Native, water-loving small-fruited bulrush are planted into exposed soil of an outside bend in Phase I, RRWMA, Lower Red River Meadow Restoration Project.

banks, former channel areas, and access roads. Prior to seeding, a finish-sized D4 bulldozer performs the final grading in construction areas and obliteration of temporary access roads. A four or six-wheeled ATV with harrow attachment follows the final grading to prepare a smooth seed bed. Using a spreader mounted on the ATV, the erosion control seed mix is broadcast over the disturbed areas. The seed mixture is comprised of the following six species and percentages:

- Sheep fescue *(Festuca ovina)* 30%
- Bromar mountain brome *(Bromus carinatus)* 30%
- Sherman big bluegrass *(Poa sandbergii)* 15%
- Canada Bluegrass *(Poa compressa)* 15%
- White dutch clover *(Trifolium repens)* 10%
- The above 5 species are mixed with ReGreen™*

**ReGreen™ is a sterile wheatgrass/wheat hybrid that establishes quickly, providing first year erosion control, and then dies out, allowing the native species to establish.*

The planted seed is subjected to a second harrowing to ensure good contact with the soil surface. A coconut fiber (coir) erosion control fabric is placed and stapled to the leading 50-foot (15-meter) edge of the reinforced bank areas (upstream ends of former channel). These areas are then re-seeded with the erosion control seed mixture. A general-purpose fertilizer (16-16-16) is applied with a hand spreader over all planted areas.

IRRIGATION. Due to low rainfall, typical during the summer months in the lower meadow, irrigation is supplied with overhead sprinklers until grass and forb seedlings are well established [> 2 inches (5 cm) tall]. Irrigation usually continues through the first week of October; thereafter, fall rains and cooler temperatures prevail. Irrigation is necessary only during the first growing season, immediately after planting, to ensure sufficient growth prior to fall dormancy and adequate erosion control for the following spring runoff. Plants utilize the natural supply of soil moisture during subsequent growing seasons.

WILDLIFE EXCLOSURES. Deer *(Odocoileus spp.)* and elk *(Cervus elaphus)* inhabit the Lower Red River Meadow and adjacent forested lands and can cause significant damage to fresh woody and herbaceous plantings. In an effort to limit and monitor ungulate browsing and to quickly establish on-site seed sources, the revegetation plan includes the construction of 20 wildlife exclosures in Phases I – IV on the RRWMA (Figure 5.5). Each 16' x 16' x 8' (4.9 m x 4.9 m x 2.5 m) exclosure consists of eight 6" x 6" x 12' (15 cm x 15 cm x 3.7 m) treated timbers placed 3 feet (0.91 meter) in the ground and eight stock panels stapled to the timbers. Cross cables and 2" x 6" x 16' (5 cm x 15 cm x 4.9 m) top boards are used to strengthen each structure. Exclosures are set with each side

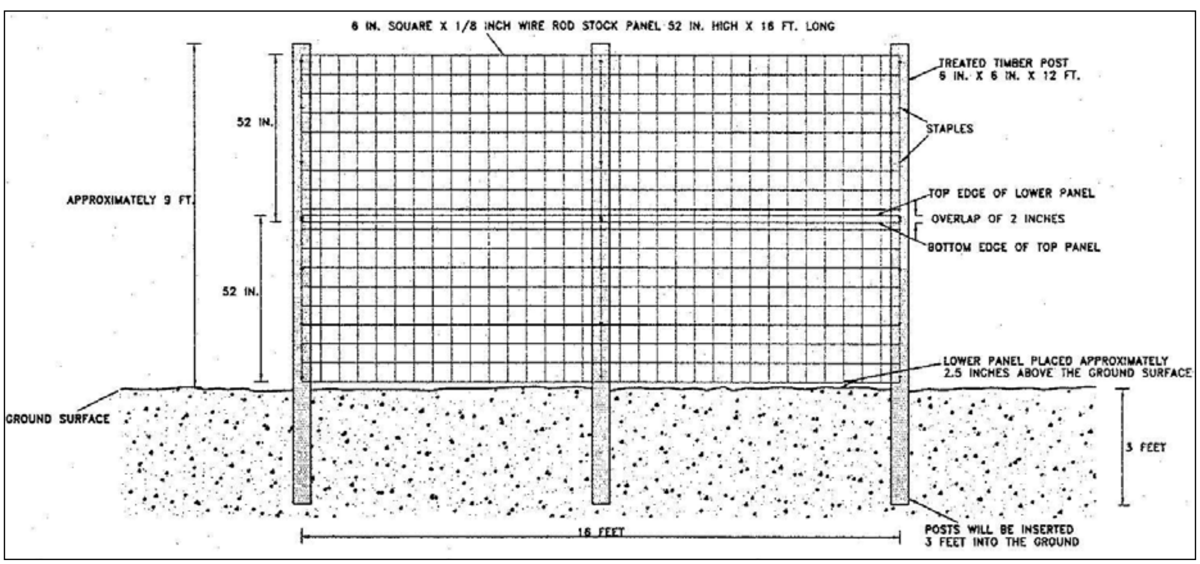


Figure 5.5 Wildlife exclosure details, cross-section view, for construction in Phases I – IV on the RRWMA, Lower Red River Meadow Restoration Project (adapted from RME, 1997).

facing one compass bearing of cardinal direction and the bottom panel on the south-facing side is fixed to drop down for access. Each exclosure is planted with a representative sample of woody seedlings and/or pole cuttings being planted in the project area (Figure 5.6).

5.3 REVEGETATION ACCOMPLISHMENTS AND CHALLENGES

During 1996 and 1997 field seasons, 31,500 woody and herbaceous riparian plants were planted in a 20-foot (6 meter) riparian buffer along the stream reaches of Phases I and II on the RRWMA (Table 5.2). An erosion control seed mix consisting of 1,400 pounds (635 kilograms) of five native grass and one naturalized forb species and 600 pounds (272 kilograms) of ReGreen™ was sown. Planted areas were supplied with a total of 2,570 pounds (1,166 kilograms) of fertilizer. Coir fiber erosion control matting was installed on the four reinforced banks and eight wildlife exclosures were constructed.

Although a majority of the plants outside the exclosures appeared to be thriving well shortly after planting, elk damaged approximately 50 of the Pacific and Geyer willow poles by stripping the bark. The damage occurred primarily to willows planted on the top of the banks of outside bends on the west side of the river. However, nearly all of the damaged plants showed new shoots growing at or near

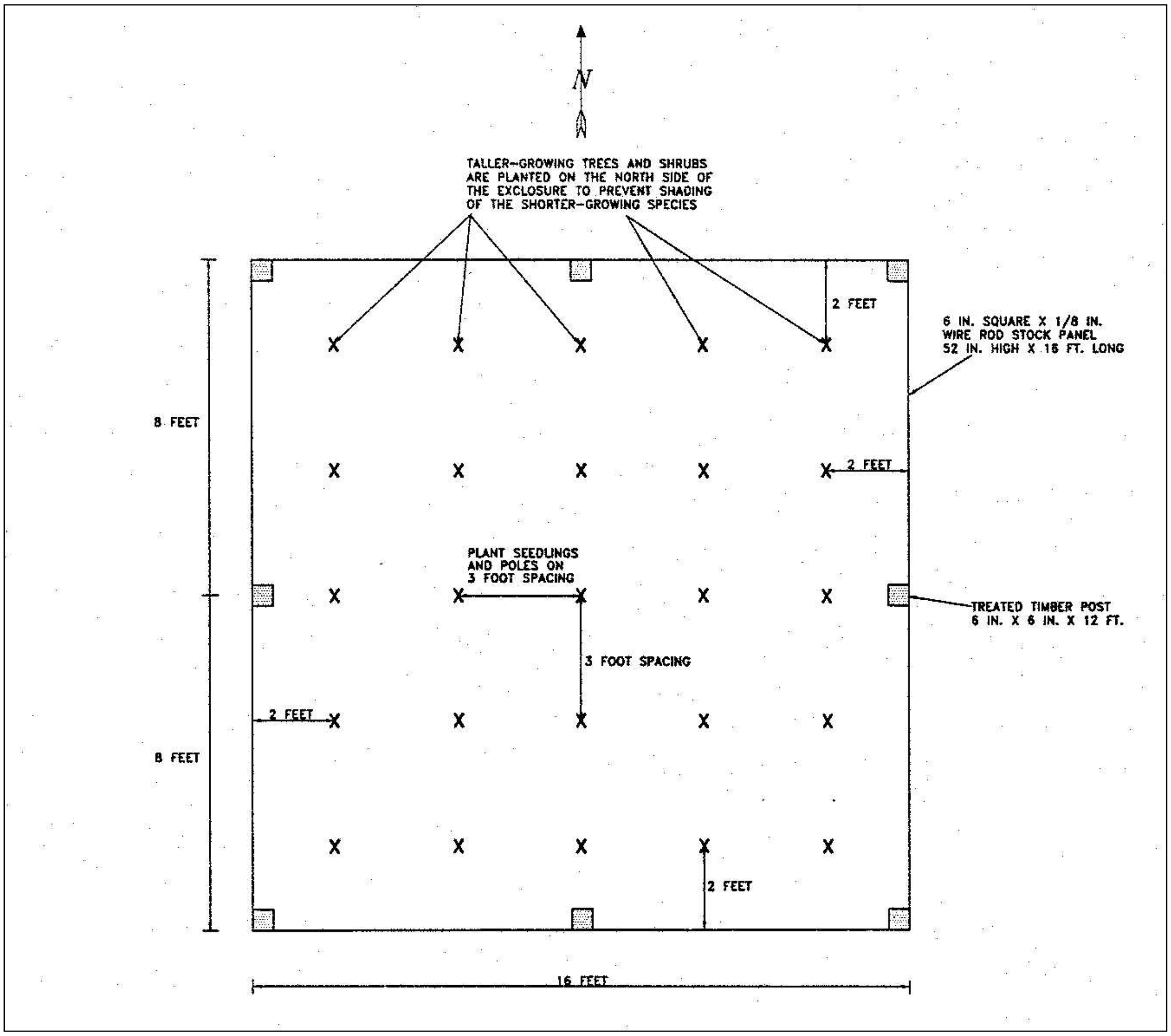


Figure 5.6 Wildlife exclosure layout. Twenty exclosures are planned for Phases I-IV on the RRWMA to document browsing impacts on newly planted vegetation and to establish islands of dense, woody vegetation that will serve as seed sources for future natural recruitment (adapted from RME, 1997).

ground level later in the growing season. A small number (< 25) of Drummond willow were damaged by beaver after initial planting.

During the 1997 field season, weather conditions changed dramatically after July 4th from cool and wet to hot [90^0F (32^0C)] and dry. Within a week, the majority of the thinleaf alder, dagger-leaf rush, and small-winged sedge that had been planted prior to July 4th displayed leaf browning. With irrigation, however, nearly all alder seedlings had grown new leaves within two weeks and the herbaceous plants had acquired extensive new growth prior to the first frost.

5.4 Expected Outcomes

In the long-term, streambank vegetation will become the natural stabilizing force, reducing erosion rates and providing shade, cover, and nutrient sources for aquatic organisms and fish. A dense and diverse riparian community will enhance wildlife habitat by providing food, cover, and nesting habitat for waterfowl, birds, and terrestrial mammals and will help lower stream temperatures as overhanging vegetation and stable undercut banks develop.

The project's long-term monitoring program will document the evolution of the expected target plant communities and the enhanced fish and wildlife habitat. First year planting success of woody and herbaceous vegetation in Phase I, evaluated from 1997 monitoring data, is discussed in Chapter 6.

Table 5.2. Numbers and species of seedlings and cuttings planted in Phases I and II on the RRWMA, Lower Red River Meadow Restoration Project, October 1997.

Common *(Scientific)* Name	1996 Phase I	1997 Phase II	TOTAL
Pole Cuttings			
Sandbar willow *(Salix exigua)*	545	-	545
Drummond's willow *(Salix drummondiana)*	3,000	355	3,355
Geyer willow *(Salix geyeriana)*	750	395	1,145
Pacific willow *(Salix lasiandra)*	525	-	525
Red-osier dogwood (*Cornus stolonifera)*	144	-	144
Subtotal	4,964	750	5,714
Herbaceous Seedlings			
Dagger-leaf rush (*Juncus ensifolius*)	1,601	1,627	3,228
Coville's rush (*Juncus covillei*)	1,600	1,087	2,687
Colorado rush (*Juncus confusus*)	300	791	1,091
Small-fruited bulrush (*Scirpus microcarpus*)	920	1,325	2,245
Small-winged sedge (*Carex microptera*)	3,286	2,510	5,796
Lens sedge (*Carex lenticularis*)	1,743	1,797	3,540
Beaked sedge (*Carex rostrata*)	1,200	1,550	2,750
Subtotal	10,650	10,687	21,337
Woody Seedlings			
Thinleaf alder (*Alnus incana*)	1,950	1,294	3,244
Red-osier dogwood (*Cornus stolonifera*)	1,000	-	1000
Serviceberry (*Amelanchier alnifolia*)	200	-	200
Subtotal	3,150	1,294	4,444
		TOTAL	**31,495**

MONITORING AND EVALUATION

University of Idaho students survey channel cross-sections. Data collected from the survey is used to evaluate stream channel response to restoration activities.

Restoration work must often be implemented without complete scientific knowledge of outcomes. Therefore, the project's monitoring program measures, evaluates, and documents the results of restoration efforts against established quantitative and qualitative performance criteria. Using adaptive management principles, engineering and revegetation designs and implementation procedures are improved in future restoration phases. Monitoring parameters, performance criteria, and methodology are also refined. Consequently, the most effective restoration techniques are being identified that optimize ecologic, geomorphic, and hydrologic conditions in the long-term. As information and data are collected, techniques and experiences are being transferred to other natural resource managers and stewards. All monitoring data is integrated into a project database and an ArcView Geographic Information System (GIS) that is maintained and updated by the University of Idaho (UI). UI plans to continue the monitoring program for research and educational purposes well after the restoration is complete.

6.1 MONITORING PLAN OVERVIEW

The post-construction monitoring program began in 1997 to assess the short- and long-term effectiveness of the restoration design and implemented features. Monitoring stations are established in Phase I and II restoration areas (Figure 6.1).

The Lower Red River Meadow Restoration Monitoring Plan (PWI, 1997) details methodology and data collection procedures performed for five short-term, or *implementation*, parameters and six long-term, or *effectiveness*, parameters. Implementation parameters are those measured during the field season or one to two years post construction and include turbidity and suspended sediment, erosion control, planting success, browsing impacts, and qualitative field reviews by the Technical Advisory Committee. Effectiveness parameters are those measured at set intervals over several years or decades and include stream channel response, fish microhabitat features, fish populations, summer water temperature regime, groundwater elevation, and riparian condition.

The UI in Boise is compiling all monitoring data into a GIS database to facilitate data analyses and technology transfer for educational and research purposes. Using adaptive management principles, monitoring and evaluation results are being used to improve the design and implementation of Phases III and IV and to refine monitoring protocols.

6.2 PARAMETERS, METHODOLOGY, AND PERFORMANCE CRITERIA

Fish migration to spawning tributaries is highly variable due to the influences of downstream conditions such as dam passage, ocean survival, fishing pressure, and climate fluctuations. Due to these off-site influences, attributing restoration features and improvements directly to changes in fish populations and densities proves difficult. Instead, many of the monitoring parameters are measurements of **physical** characteristics directly related to the development of high quality spawning and rearing habitat. Consequently, the monitoring plan relies on the assumption that restoring high quality fish habitat will attract more spawners, increase survival rates of juvenile and adult fish, and allow more offspring to migrate to the ocean.

Monitoring parameters, methodology, and performance criteria are described in Table 6.1.

Implementation Parameters

TURBIDITY AND SUSPENDED SEDIMENT. Construction-related turbidity and suspended sediment load are measured to evaluate the effectiveness of the project's BMPs and to document the project's compliance with Idaho State Water Quality Standards (DEQ, 1996).

EROSION CONTROL. Areas disturbed by construction equipment are seeded with a native grass/forb mixture to control erosion. Percent coverage is calculated one year post construction and used in re-seeding decisions.

PLANTING SUCCESS. Percent survival rates of woody and herbaceous cuttings and seedlings, one year post installation, determine replanting needs. This information also guides woody and herbaceous species selection, planting location, and out-planting methods in future phases of the project.

BROWSING IMPACTS. Wildlife exclosures provide qualitative and quantitative information regarding the impacts of deer and elk browsing on newly planted vegetation. Data results aid decision-making for browse control management.

TECHNICAL ADVISORY COMMITTEE (TAC) FIELD REVIEWS. The TAC advises consultants and construction crews on changes in design or construction techniques whenever unexpected field season site conditions make the original design inappropriate. The group also identifies areas of concern and recommends repair or maintenance during post-flood and low-flow field reviews performed in June and September, respectively.

Effectiveness Parameters

STREAM CHANNEL RESPONSE. Stream channel response to construction is measured to evaluate engineering design and performance of constructed features, channel evolution toward dynamic equilibrium, and

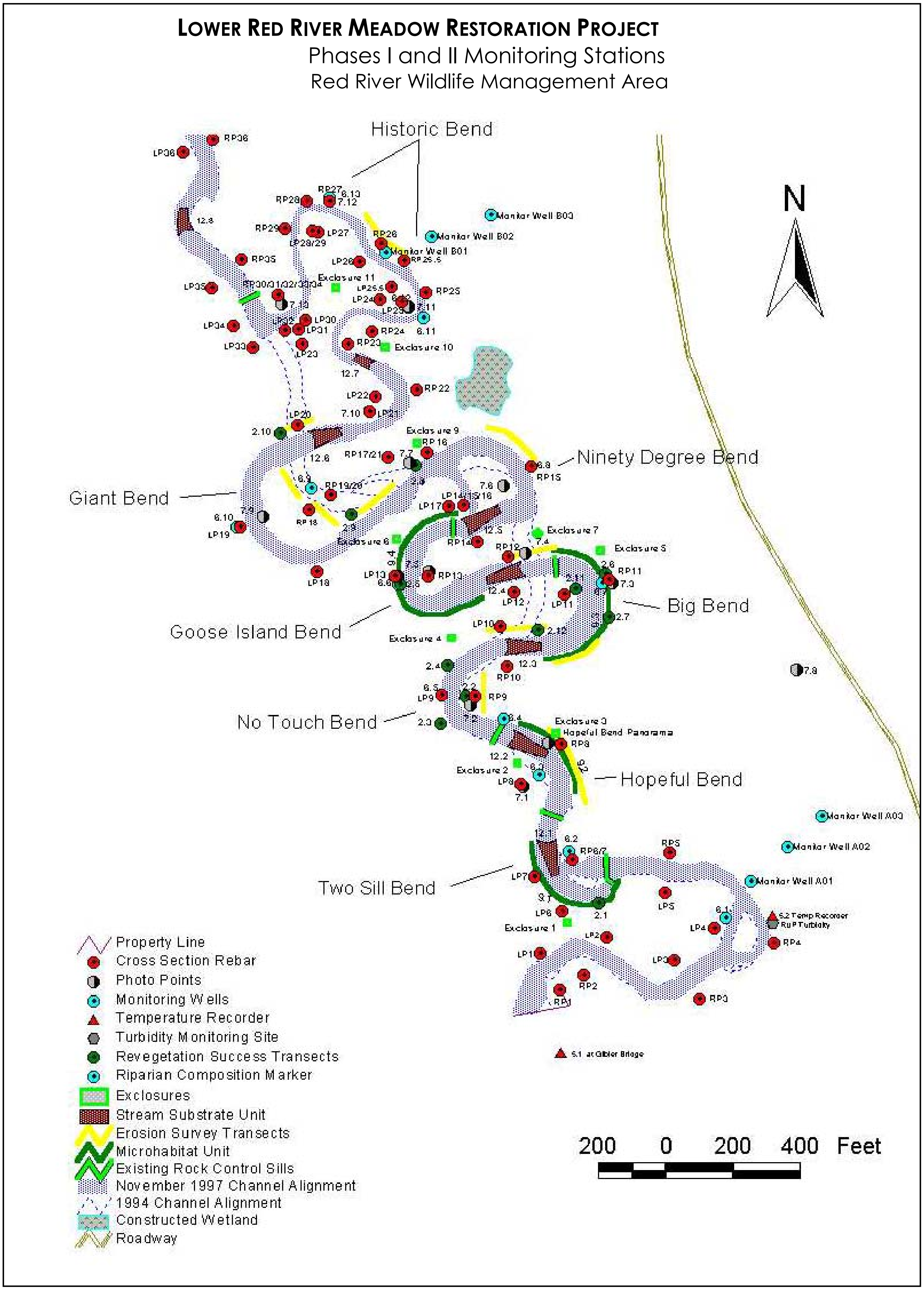


Figure 6.1. Descriptions and locations of monitoring sites and survey transects in Phases I and II, RRWMA, Lower Red River Meadow Restoration Project (UI Eco-hydraulics Research Group, unpublished GIS map, 1999).

Table 6.1. Descriptions of implementation (short-term) and effectiveness (long-term) monitoring parameters, methodology, and performance criteria used in the Lower Red River Meadow Restoration Monitoring Program, 1997.

Monitoring Parameter	Methodology	Frequency/Timing	Performance Criteria
Implementation			
1. TURBIDITY/SUSPENDED SEDIMENT	a) Electronic, optical turbidity sensors record turbidity (NTU) every 10 minutes. Sensors are placed upstream of construction (measures background NTU), downstream of construction area, and at the end of the lower meadow. Additional sensors are added as necessary to monitor construction impacts to activities downstream of the lower meadow. b) Manual sediment samples are collected to calibrate electronic recorders and used to estimate daily and project sediment load (tons).	a) Continuously during each field season, June 15th – September 15th. Data is downloaded once per week. b) Once per field season	a) During construction, the project uses best management practices to comply with Idaho Water Quality Standards. Construction-related turbidity is not to exceed background turbidity (3 NTU) by more than 50 NTU instantaneously or more than 25 NTU for more than ten consecutive days (DEQ, 1996): **Project standard ≤ 53 NTU.** b) Construction-related sediment load is not to exceed 150 tons in accordance with the project's Environmental Analysis (BPA, 1996).
2. EROSION CONTROL	A ¼ metric square is laid along each meter increment of six, representative 50-meter (164-foot) transects in construction–related disturbed areas. Percent cover of native grass/forb is estimated to the nearest 10% and the mean of the 50 plots is calculated.	One field season post-construction/ Mid-July	Reseeding will normally occur when native grass/forb coverage is less than 50% after the first year of growth, depending on the erosive potential of each location.
3. PLANTING SUCCESS	Newly planted riparian species are identified and mapped in 1 x 1 meter plots along twelve, representative 50-meter (164-foot) transects. Plots are resurveyed the following summer to calculate % survival of individual species.	Mapping completed the same season as planting/ Late Sept. – early Oct. Re-survey the following year/ early July	Replanting will normally occur when herbaceous and woody plant mortality is greater than 50% after the first year of growth. In certain cases, replanting will occur when plant mortality is less than 50% depending on the value, function, and potential for natural recruitment of an individual species.
4. BROWSING IMPACTS	Number and length of primary and secondary stems of woody species planted inside the wildlife exclosures are compared to those planted outside.	Two years post-planting/ Late Sept. – early Oct.	To be determined. Planting species inside wildlife exclosures helps determine the effects of browsing over time on the establishment of native riparian shrubs. Following analysis of initial results (two years post planting), the project team will choose a course of action necessary to protect shrubs outside the exclosures from herbivory, such as but not limited to, elk/deer repellent spray, fencing, tree tubes, and/or pole length modifications.

Table 6.1 cont. Descriptions of implementation (short-term) and effectiveness (long-term) monitoring parameters, methodology, and performance criteria used in the Lower Red River Meadow Restoration Monitoring Program, 1997.

Monitoring Parameter	Methodology	Frequency/Timing	Performance Criteria
Implementation (cont.)			
5. TECHNICAL ADVISORY COMMITTEE FIELD REVIEWS	Field reviews provide feedback on project design, implementation, and performance using visual, qualitative assessments and standardized field forms (Appendix D). Results are documented in formal Field Review Reports.	Three times per year. ▪ early June *(after peak seasonal flows)* ▪ mid August *(during construction)* ▪ late September *(low flow)*	The TAC assesses the integrity and value of the restored habitat features and initial evidence that the reconstructed channel and revegetated riparian zone are functioning as designed or evolving toward dynamic equilibrium, consistent with project goals, objectives, and design philosophy. Qualitative observations are compared to construction performance criteria that include feature functions and expected results and are part of the standardized field forms.
Effectiveness			
6. STREAM CHANNEL RESPONSE	Total Station or GPS survey equipment is used to survey channel cross-sections, thalweg profile, and surface water elevations. Currently, 50 representative cross-sections have been permanently monumented on the RRWMA, allowing repeatability over time.	<u>Each phase – short-term</u>: 1) October, one year prior to construction 2) October, immediately post construction <u>Entire meadow reach – long-term</u>: October, annually, for 10 – 15 years.	Stream gradient, sinuosity ratio, and meander pattern are constructed according to design criteria and as specified in design documents. The design allows for stream evolution into a stable, self-regulating state. Stream channel stability is a dynamic process in which a stream adjusts its form (i.e., local gradients and velocities, bed material arrangement, channel pattern) in response to natural fluctuations in discharge and sediment in order to maintain a balance between sediment supply and sediment transport.
a) Sinuosity Ratio	Calculated from survey data and GIS output *(stream length/valley length)*	Reported pre-construction and one year post-construction, biennially thereafter	Approximate 1936 conditions = 2.4 ± 20% Target time frame: 1 year post construction
b) Channel Gradient	Calculated from survey data and GIS output *[(feet of water surface elevation drop/feet of channel length)(100)]*	Reported pre-construction and one year post-construction, biennially thereafter	Approximate 1936 conditions = 0.17% ± 20% Target time frame: 1 year post construction
c) Low-Flow Water Surface Elevation	Recorded during survey	Reported pre-construction, one year post-construction, and biennially thereafter	Low-flow water elevations to within 36 inches (91 cm) of top of bank. Target time frame: 1 – 3 years post construction
d) Pool/Riffle Habitat	Calculated from survey data and GIS output	Reported biennially	Increase pool numbers by > 50% Target time frame: 1 –3 years post construction
e) Residual Pool Depth	Calculated from survey data and GIS output	Reported biennially	Increase average residual pool depths by ≥ 0.5 feet (15 cm) Target time frame: 1 –3 years post construction

Table 6.1 cont. Descriptions of implementation (short-term) and effectiveness (long-term) monitoring parameters, methodology, and performance criteria used in the Lower Red River Meadow Restoration Monitoring Program, 1997.

Monitoring Parameter	Methodology	Frequency/Timing	Performance Criteria
Effectiveness (cont.)			
6. STREAM CHANNEL RESPONSE (CONT.)			
f) Width/Depth	Calculated from survey data and GIS output *(bankfull width/bankfull mean depth)*	Reported biennially	Within range for "typical" reach specified in project design documents. Target time frame: 1 – 3 years post construction
g) Lateral Bank Erosion	Calculated from survey data and GIS output	Reported biennially	Lateral bank erosion will decrease compared to pre-construction conditions as the channel stabilizes; average erosion rates should match those of a channel in dynamic equilibrium, a state in which no net erosion occurs - quantitative performance criteria are being investigated. Target time frame: 3 – 10 years post construction
h) Point Bar Aggradation	Calculated from survey data and GIS output	Reported biennially	Oversized channels constructed in Phases I and II were designed to slow water velocity in the short-term and facilitate point bar aggradation in the long term. As the channel evolves toward dynamic equilibrium, no net deposition should occur - quantitative performance criteria are being investigated Target time frame: 3 – 10 years post construction
i) Substrate Composition	Wolman pebble count procedure (Wolman, 1954) at representative transects, targeting pool-tailouts/riffles.	Biennially/Low-flow (September – October)	N/A. Information from measurement of this parameter is used to understand how the system is evolving and how accurately the project is predicting design outcomes related to sediment transport and deposition. This evaluation will improve designs in the future and aid in the transfer of stream restoration knowledge and technology. D50, D84, and percent fine measurements are recorded, with the long-term development of "optimal conditions" driven by preferred fish habitat criteria (see microhabitat features below). Target time frame: 3 – 10 years post construction
7. MICROHABITAT FEATURES			Based on habitat preferences of chinook salmon (Bjornn and Reiser, 1991; NMFS, 1996)
a) Rearing Habitat	Auto level and flow meter are used to measure water velocity, depth, and channel cross-section dimensions along multiple cross-section transects in representative meander bends.	One-year post construction, thereafter biennially/Low-flow (September)	**Depth of pool** $\geq$ 0.5 ft (15 cm) **Velocity** = 0.26 – 2.0 ft/s (8 – 60 cm/s) **50 % of meander bend in target condition** Target time frame: 3 – 5 years post construction

Table 6.1 cont. Descriptions of implementation (short-term) and effectiveness (long-term) monitoring parameters, methodology, and performance criteria used in the Lower Red River Meadow Restoration Monitoring Program, 1997.

Monitoring Parameter	Methodology	Frequency/Timing	Performance Criteria
Effectiveness (cont.)			
7. MICROHABITAT FEATURES (CONT.)			
b) Spawning Habitat	Auto level and flow meter are used to measure water velocity and depth along multiple cross-section transects in representative spawning areas. Wolman pebble counts (Wolman, 1954) are used to calculate dominant particle size, D-50, and percent fines.	One-year post construction, thereafter biennially /Low-flow (September)	**Water depth** = $\geq$ 1.0 ft ($\geq$ 30 cm) **Velocity** = 1.0 – 4.0 ft/s (30 – 122 cm/s) **Substrate size** = D50 = 0.5 – 4.0 in (13 – 102 mm) **Percent fines** (< 6 mm) = $\leq$ 20% **50 % of spawning areas in target condition** Target time frame: 3 – 5 years post construction
8. FISH POPULATIONS	Eleven transects consisting of a pool/riffle/run sequence or one of these habitat types are established in the lower meadow. Fish populations and densities are evaluated by IDFG using the following methods: ♦ Snorkel counts: surface area per habitat type is measured and calculated; species type, number, and size are recorded (Bowles and Leitzinger, 1991). ♦ Ground and aerial redd counts (Bowles and Leitzinger, 1991; Hassemer, 1993).	Snorkel transect counts – annually/July Redd counts – annually/ August – September	Long-term trend of increasing numbers of chinook salmon spawners and a larger percentage of total species composition and increased densities of steelhead and chinook juveniles in the restored reaches of Red River. Target time frame: N/A
9. WATER TEMPERATURE REGIME	Continuous, waterproof data loggers are placed in four locations throughout the entire meadow. Temperature loggers are placed in weighted containers and located to avoid surface temperature fluctuations. Temperature accuracy is evaluated using a calibrated thermometer and manual measurements. Two air temperature monitors are also set up on the RRWMA.	Data collected continuously from July 1 – September 15	Maintain summer water temperatures to $\leq$ 64.9°F (18.3°C), considered optimal for juvenile chinook salmon rearing (ISG, 1996). Satisfying this criterion is dependent on development of overhanging vegetation, undercut banks, deep pools, and narrower channel reaches. Target time frame: 10 – 20 years post construction

Table 6.1 cont. Descriptions of implementation (short-term) and effectiveness (long-term) monitoring parameters, methodology, and performance criteria used in the Lower Red River Meadow Restoration Monitoring Program, 1997.

Monitoring Parameter	Methodology	Frequency/Timing	Performance Criteria
Effectiveness (cont.)			
10. GROUNDWATER ELEVATION	Groundwater monitoring standpipes are installed in 14 locations throughout the floodplain and riparian zone of the entire RRWMA. Manual measurements recorded monthly.	Monthly readings/May – Oct.	Maintain groundwater elevation to ≤ 3.3 feet (1 meter) below soil surface during growing season to provide adequate soil moisture in root zone of native riparian plant communities. Target time frame: 2 – 5 years post construction
11. RIPARIAN CONDITION			
a) Riparian Vegetation Composition	Modified Green Line Method (Cagney, 1993): Ocular estimates of percent coverage are recorded along eight, paired 50 m x 2 m (164 ft x 6.6 ft) transects, located parallel and immediately adjacent to the water's edge. Modified Riparian Composition Transect Method (USDA, 1992): Plant communities are identified along eight 100 m x 2 m (328 ft x 6.6 ft) transects, located perpendicular to the stream channel. Ocular estimates are made for species presence along the transect, and recorded as dominate, subdominate, 25%, or 10% of total ground coverage.	Biennially at peak of growing season/Late July – early August	The composition of the plant community will be compared to the expected target plant community: ▪ <u>Wetter sites</u> = *Salix drummondiana*/Carex *rostrata* or *Salix geyeriana/Carex rostrata*. ▪ <u>Drier sites</u> = *Salix/Calamagrostis canadensis* or *Salix/Deschampsia cespitosa* Restored riparian communities will evolve toward the target plant communities, becoming dominant plant cover (> 50% of total ground coverage) in the riparian zone. Target time frame: 8 – 10 years post installation
b) Photopoints	Thirteen permanent photopoint stations and two panoramic stations are established. A standard profile board marked in one-foot increments is included in photos.	Photos taken immediately after restoration work in construction reaches. Subsequent photos are documented annually/Once per month during field season, June – Sept.	N/A (Photos are compared over time to qualitatively illustrate the development of riparian vegetation and changes in stream bank conditions.)
12. WILDLIFE HABITAT	Habitat Evaluation Procedure (HEP) based on Habitat Suitability Index (HSI) Models (USFWS, 1980; USFWS, 1986].	Baseline (1997), then every 3 years/September	Long-term increase in habitat value defined by semi-quantitative HSI measurements that range from 0.0 (unsuitable habitat) to 1.0 (optimum habitat) for indicator species – white-tailed deer, yellow warbler, mallard, and mink.

development of high quality and diverse fish habitat features. Total Station or Geographic Positioning System (GPS) survey equipment is used to survey channel cross-sections, thalweg profile, and surface water elevations. Currently, 50 representative cross-sections have been permanently monumented on the RRWMA, allowing repeatability over time. Maps and graphs are produced using GIS technology to illustrate changes in the channel's physical characteristics and macro-habitat quality and quantity. The following features are documented in the stream channel response analysis:

- Sinuosity Ratio
- Channel Gradient
- Low-Flow Water Surface Elevation
- Pool/Riffle Habitat
- Residual Pool Depth
- Width/Depth Ratio
- Lateral Bank Erosion
- Point Bar Aggradation
- Substrate Composition

MICROHABITAT FEATURES. Water velocity, water depths, substrate size, and percent fines are measured in spawning and rearing areas and compared to scientifically documented chinook salmon preferences. This information is used to document evolution of the restored channel reaches toward spawning and rearing habitat conditions preferred by chinook salmon.

FISH POPULATIONS. Snorkel transect surveys used to estimate fish populations have been conducted by IDFG fisheries personnel on annual basis in the lower Red River meadow since 1986 and on the RRWMA since 1994 (Appendix B). The IDFG has also documented chinook salmon redds using both aerial and ground survey techniques annually since 1992. The project will use this data to track long-term trends in numbers of chinook spawners, fish species composition percentages, and numbers of rearing juveniles. Trends in fish population and redd count data in the restored project reaches are compared to non-restored reaches and to overall trends in the Red River drainage and other drainages within the SFC subbasin.

WATER TEMPERATURE REGIME. Elevated summer water temperatures in the portion of Red River flowing through the lower meadow provide suboptimal conditions for native fish species (Figure 6.2). Channel reconstruction will create smaller width/depth ratios and increase the number of deep pools. Riparian plantings will provide shade as overhanging vegetation and stable undercut banks develop. Reducing summer water temperatures will depend on the long-term development of these features.

GROUNDWATER ELEVATION. Adding length to the stream channel and installing grade control structures will increase surface water elevations. An associated increase in groundwater elevation adjacent to the stream is expected as well as an increase in the duration and frequency of flooding onto the floodplain. Changes in groundwater elevation over time are measured to determine the effectiveness of the restoration design to create soil moisture conditions conducive to the establishment, natural recruitment, and sustainability of the native riparian plant species.

RIPARIAN CONDITION. The evolution of the target riparian plant communities is documented using greenline, riparian composition, and photopoint surveys. The long-term development of a dense and diverse native plant community will play a major role in streambank stability, reduced erosion rates, overhead cover and shade, instream woody debris, and wildlife habitat.

HABITAT EVALUATION PROCEDURE. Enhancement of wildlife habitat quantity and quality due to restoration activities is tracked over time using the Habitat Evaluation Procedure (HEP) (USFWS, 1980). During the summer of 1997, IDFG assisted the project team in collecting baseline data for four target species in the meadow: white-tailed deer *(Odocoileus virginianus)*, yellow warbler *(Dendroica petechia)*, mink *(Mustela vison)*, and mallard *(Anas platyrhynchos)*.

6.3 RESTORATION PERFORMANCE REVIEW

Monitoring data collected during the 1997 field season in Phases I and II has been analyzed and compiled into an annual monitoring report (PWI, 1998). With one exception (turbidity levels occasionally exceeded water quality standards for a limited time), the project's

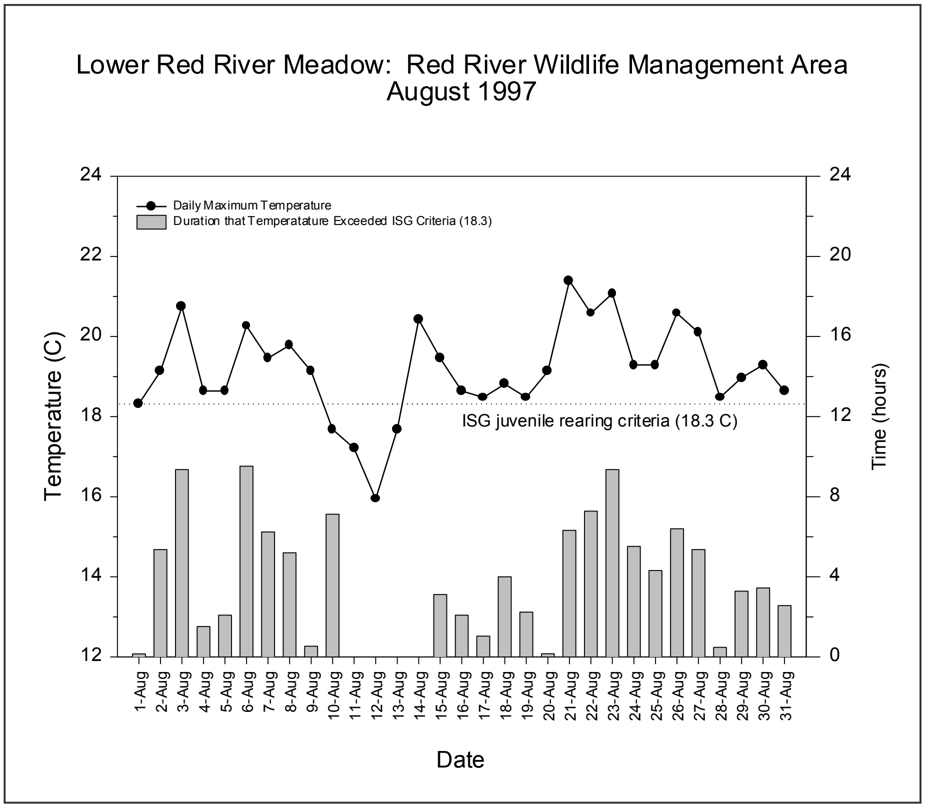


Figure 6.2 Maximum daily stream temperature and duration of temperature exceeding the juvenile chinook rearing criterion during August 1997 on the RRWMA, Lower Red River Meadow Restoration Project.

short-term, or implementation, performance was successful (Table 6.2). As an example, the average first-year survival rate of all herbaceous and woody riparian plantings equaled 83 percent, well above the established performance criterion of 50 percent.

Post-restoration measurements of sinuosity, gradient, pool numbers, and average residual pool depth achieved the established performance criteria. Analyses of the remaining long-term, effectiveness parameters document either baseline post-restoration conditions or early stages of evolution toward desired conditions (Table 6.2). These baseline and evolutionary conditions are expected given that the 1997 monitoring data was collected either immediately post-restoration (Phase II) or only one-year post restoration (Phase I). Evolution of the stream channel and associated wet meadow ecosystem into a state of dynamic equilibrium will occur during the next several years or decades. Tracking the incremental steps of this evolution, however, allows the project to identify aspects of the design and implementation that may need improvement in future phases of the restoration.

6.4 ADAPTIVE MANAGEMENT IMPLICATIONS/STRATEGIES

An adaptive management process (Figure 6.3) uses the short- and long-term monitoring information to improve design and implementation as well as refine monitoring protocols, methods, and performance criteria. As a result, the project is identifying the most effective restoration techniques to optimize ecologic, geomorphic, and hydrologic conditions and improve habitat for existing and potential fish and wildlife species in the meadow.

The project team gained valuable experience in several areas of river restoration and has used these lessons to modify and improve designs, implementation procedures, and monitoring protocol (Table 6.2).

Although the project objectives and philosophy

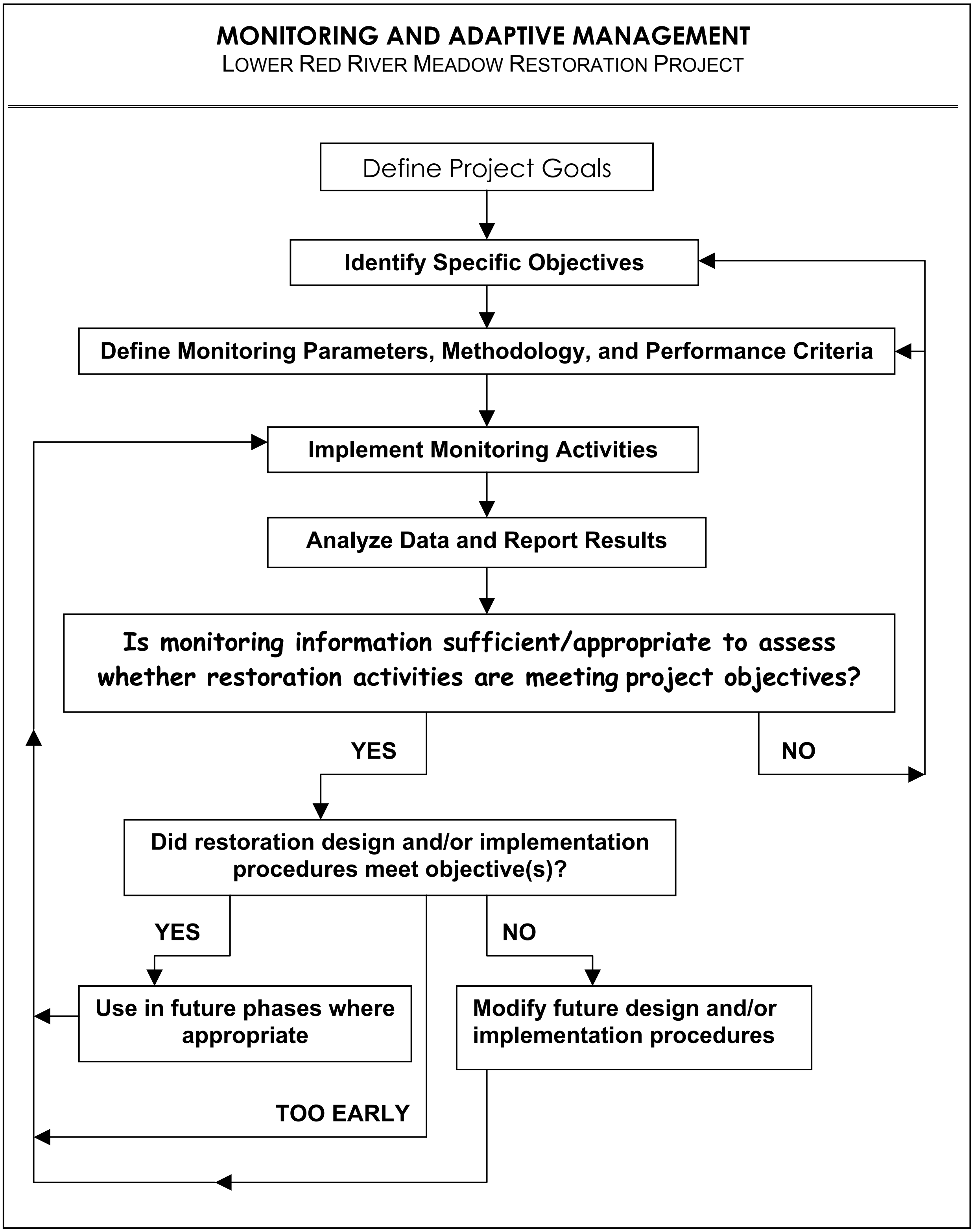


Figure 6.3 Monitoring information is used in an adaptive management strategy, illustrated by this flow chart, to help the Lower Red River Meadow Restoration Project refine monitoring protocols and improve restoration designs and implementation techniques in future phases.

Table 6.2. Summary of 1997 monitoring results, performance evaluation, and adaptive management implications for Phases I and II, RRWMA, Lower Red River Meadow Restoration Project (PWI, 1998).

Monitoring Parameter	Monitoring Results	Performance Criteria Met?	Adaptive Management Implications/Strategies
Implementation			
1. TURBIDITY/SUSPENDED SEDIMENT	a) Although several BMPs were used (Table 4.2), turbidity exceeded 53 NTUs for limited periods during August 5th – August 15th, 1997. b) Project-related sediment load was estimated at 124 tons immediately below construction and at 135 tons at the end of the lower meadow, approximately 2.5 miles (4.0 kilometers) downstream.	**a) YES/NO** **b) YES**	During the field season, daily turbidity summaries are provided to project management and then incorporated into weekly project updates. DEQ received a daily notice whenever turbidity exceeded the water quality criterion of 53 NTUs. Best management practices were modified whenever short-term infractions occurred to comply with standards for the remainder of the field season. A feedback loop report was submitted to DEQ on October 10, 1997 (Appendix C). Negative impacts to dredge miners downstream occurred at construction-related turbidity well below 50 NTUs. In an effort to cooperate with mining activities, the project timed major in-channel work for late afternoon so that the turbidity plume would occur after daylight hours. Experiences and new information will be used to revise and improve sediment controls methods in future phases.
2. EROSION CONTROL	Mean percent cover in the six-erosion control transects ranged from 28 to 61.	**YES**	Low percentages for seeding success in some transects are attributed to the timing of data collection. Measurements were taken too early in the growing season (June 8). Coverage was observed at greater percentages in the middle of the growing season. Therefore, timing of data collection for this parameter will be moved to mid-July.
3. PLANTING SUCCESS	Overall survival rate of herbaceous and woody riparian plantings averaged 83%.	**YES**	N/A
4. BROWSING IMPACTS	N/A (data collected in 1998)	**N/A**	N/A

Table 6.2 cont. Summary of 1997 monitoring results, performance evaluation, and adaptive management implications for Phases I and II, RRWMA, Lower Red River Meadow Restoration Project (PWI, 1998).

Monitoring Parameter	Monitoring Results		Performance Criteria Met?	Adaptive Management Implications/Strategies
Implementation (cont.)				
5. TECHNICAL ADVISORY COMMITTEE FIELD REVIEWS	TAC drafted performance evaluation criteria and field forms to use for field reviews (Appendix D). One field review* was held in August 1997. At this time, the TAC advised the construction and consultant teams regarding minor post-restoration enhancement work in Phase I and construction alternatives for unanticipated high flow conditions during Phase II construction. **The first formal post-flood and low-flow field reviews will be performed in 1998.*		**N/A**	**Phase I:** 1) Increased the density of willow and herbaceous plantings on Hopeful Barb Bend due to a higher than anticipated erosion rate. 2) Increased the density of willow plantings on inside point bar of Big Bend to accelerate fine material deposition and narrowing of the channel width. **Phase II:** 1) Selected design for alignment and cross-sectional shape of Giant Bend. 2) Reviewed alternatives provided by the on-site engineer and selected an approach to address unanticipated site conditions during field season. 3) Placed additional erosion control matting at downstream end of former channel located near the beginning of Phase III. Low elevation due to lack of fill for this area raised concern for future headcutting. 4) Gained experience related to installation of diversion structures during above average water flows, construction in wet meadow conditions, the importance of accurate cut/fill estimates, turbidity monitoring, effectiveness of BMPs for sediment control, and impacts of sediment release on downstream users.
Effectiveness				
6. STREAM CHANNEL RESPONSE				
	Pre-Construction	Post-Construction		
a) Sinuosity Ratio (Entire RRWMA)	1.7	2.3	**YES**	N/A
b) Channel Gradient (Entire RRWMA)	0.24%	0.18%	**YES**	N/A
c) Number of Pools (Phases I and II only)	14	22	**YES**	N/A
d) Average Residual Pool Depth (feet) (Phases I and II only)	1.0	1.6	**YES**	N/A

Table 6.2 cont. Summary of 1997 monitoring results, performance evaluation, and adaptive management implications for Phases I and II, RRWMA, Lower Red River Meadow Restoration Project (PWI, 1998).

Monitoring Parameter	Monitoring Results	Performance Criteria Met?	Adaptive Management Implications/Strategies
Effectiveness (cont.)			
6. Stream Channel Response (cont.)			
a) Low-Flow Water Surface Elevation	N/A (to be documented in 1998-99 report)	**N/A**	In 1999 field season, top of bank measurements will be taken, longitudinally between permanent cross-sections. Distance to top of bank from low-flow surface water elevation at representative reaches will be calculated.
b) Width/Depth Ratio	N/A (to be documented in 1998-99 report)	**N/A**	TAC dissatisfied with the intentionally "over-widened" design of the newly constructed reaches in Phases I and II. The projected time frame for these cross-sections to develop into the target W/D is longer than initially expected, increasing the time for the evolution of adequate fish habitat conditions. Field observations of Historic S-Curve Loops suggested that slightly narrower channel cross-sections may develop higher quality fish habitat and evolve toward dynamic equilibrium sooner than the cross-sections previously designed. A decision was made to design Phases III and IV with narrower cross-sections.
c) Lateral Bank Erosion	N/A (to be documented in 1998-99 report)	**N/A**	N/A
d) Point Bar Aggradation	N/A (to be documented in 1998-99 report)	**N/A**	N/A
7. Microhabitat Features			
a) Rearing Habitat (Phase I only)			Substrate and cover will be evaluated in future reports.
• Two Sill Bend	Percentage of transect lengths that met depth and velocity criteria ranged from 10-70% with a mean of 49%	**EVOLVING**	Baseline Measurement – post construction
• Hopeful Bend	Percentage of transect lengths that met depth and velocity criteria ranged from 0-90% with a mean of 43%	**EVOLVING**	Baseline Measurement – post construction

Table 6.2 cont. Summary of 1997 monitoring results, performance evaluation, and adaptive management implications for Phases I and II, RRWMA, Lower Red River Meadow Restoration Project (PWI, 1998).

Monitoring Parameter	Monitoring Results	Performance Criteria Met?	Adaptive Management Implications/Strategies
Effectiveness (cont.)			
7. MICROHABITAT FEATURES (CONT.)			
a) Rearing Habitat (Phase I only) (Bend locations in Figure 6.1)			Substrate and cover will be evaluated in future reports.
• Big Bend	Percentage of transect lengths that met depth and velocity criteria ranged from 9-100% with a mean of 65%	**EVOLVING**	Baseline Measurement – post construction
• Goose Island Bend	Percentage of transect lengths that met depth and velocity criteria ranged from 0-89% with a mean of 26%	**EVOLVING**	Baseline Measurement – post construction
b) Spawning Habitat (Phase I only) (Unit locations in Figure 6.1)			
• Stream Substrate Unit 12.1	Dominant particle size = < 6 mm D50 = 6-8 mm Percent fines = 20%	**EVOLVING**	1) Velocity and water depth will be measured in future surveys 2) Substrate unit 12.1 was located upstream from a rock control sill and therefore, within a depositional reach rather than a pool tail-out and was relocated in 1998 to better target pool-tailouts 3) Wolman Pebble Count method may be unreliable for determining small size classes. In 1998, will use Grid Method (Overton et al., 1997) and compare the two methods in future analysis.
• Stream Substrate Unit 12.2	Dominant particle size = 32 – 48 mm D50 = 12-18/24-32 mm *(repeated samples resulted in two D50 measures)* Percent fines = 33%	**EVOLVING**	1) Same comments as 1) and 3) above 2) Substrate unit 12.2 was located upstream from a rock control sill and therefore, within a depositional reach rather than a pool tail-out and was relocated in 1998 to better target pool-tailouts.

Table 6.2 cont. Summary of 1997 monitoring results, performance evaluation, and adaptive management implications for Phases I and II, RRWMA, Lower Red River Meadow Restoration Project (PWI, 1998).

Monitoring Parameter	Monitoring Results	Performance Criteria Met?	Adaptive Management Implications/Strategies
Effectiveness (cont.)			
7. MICROHABITAT FEATURES (CONT.)			
b) Spawning Habitat cont. (Phase I only)			
• Stream Substrate Unit 12.3	Dominant particle size = < 6 mm D50 = < 6 mm Percent fines = 62%	**EVOLVING**	1) Same comments as 1) above 2) This unit is located in the straight reach, newly constructed in 1996. The reach was excavated from meadow soils upstream from the new Big Bend. Both Big Bend and Goose Island Bend act as controls for water surface elevation. Consequently, water velocities at high flows were ineffective at scouring out fine material remaining from construction. 3) This reach is not currently moving fines. Note hydrologic and geomorphic characteristics to modify future designs.
• Stream Substrate Unit 12.4	Dominant particle size = 24-32 mm D50 = 18-24/24-32 mm *(repeated samples resulted in two D50 measures)* Percent fines = 17%	**EVOLVING**	1) Same comments as 1) above 2) Possible model reach; note hydrologic and geomorphic characteristics to incorporate in future designs.
• Stream Substrate Unit 12.5	Dominant particle size = 32-48 mm D50 = 24-32/32-48 mm *(repeated samples resulted in two D50 measures)* Percent fines = 17%	**EVOLVING**	1) Same comments as 1) above 2) Possible model reach; note hydrologic and geomorphic characteristics to incorporate in future designs.
8. FISH POPULATIONS	N/A (Trends in species type, size, and density and number of redds within the lower Red River will be reported in 1998-99)	**N/A**	N/A

Table 6.2 cont. Summary of 1997 monitoring results, performance evaluation, and adaptive management implications for Phases I and II, RRWMA, Lower Red River Meadow Restoration Project (PWI, 1998).

Monitoring Parameter	Monitoring Results	Performance Criteria Met?	Adaptive Management Implications/Strategies
Effectiveness (cont.)			
9. WATER TEMPERATURE REGIME	Temperatures exceeded maximum of 18.3 °C (64.9°F) frequently during July, August, and Sept.	**EVOLVING**	N/A
10. GROUNDWATER ELEVATION	N/A (In 1997, only three groundwater wells were established to test equipment effectiveness, installation procedures, and data collection methods)	**N/A**	Limited baseline data was collected during 1997. Experiences were used to refine monitoring well installation and data collection methods in the 1998 field season. Results will be reported in 1998-99.
11. RIPARIAN CONDITION			
a) Riparian Vegetation Composition	N/A (To be reported in 1998-99)	**N/A**	In addition to greenline and riparian composition measurements, overhanging vegetation, undercut banks, and bank stability will be added to the long-term monitoring parameters and measured at appropriate intervals in future years.
b) Photopoints	Selected photopoint slides are documented in the 1997 Monitoring Report Appendices (PWI, 1998). The remainder of the slides is being archiving into project files.	**N/A**	Photopoint slide cataloging and storage options are being researched to provide an efficient method for archival and transfer of images between consultants, to the project web site, and for preparing slide presentations, newsletters, etc.
12. WILDLIFE HABITAT	N/A (To be reported in 1998-99)	**N/A**	N/A

remained unchanged, several design features were modified. For instance, the log habitat structures placed in the outside banks of Phase I (1996) proved ineffective as fish habitat and were excluded from Phase II (1997) design. Microhabitat data results allowed the engineering designers to select model reaches that satisfied the performance criteria for spawning and rearing habitat as guides for Phase III and IV design. Field observations of Historic S-Curve Loops suggest that slightly narrower channel cross-sections may develop higher quality fish habitat and evolve toward dynamic equilibrium sooner than cross-sections previously designed in Phases I and II. Narrower channels are designed for Phases III and IV and will be constructed in 1999 and 2000, respectively.

During implementation, the project team gained an understanding of the relationships between proper construction sequencing and adequate timing that ensures the slow release of construction-induced turbid water. Knowledge of these relationships is key to mitigating suspended sediment impacts and will be incorporated into a revised sediment and erosion control plan for future field seasons. The project team also gained experience working in above average rainfall and stream discharge conditions and recognized the value of effective contingency plans.

The turbidity monitoring protocol was refined and data collection stations expanded during the 1997 field season to coordinate activities with downstream users and to document turbidity levels for DEQ. The continuous availability of turbidity data allowed the construction team to quickly respond to short-term turbidity levels that rose above the water quality standard. By modifying construction activities or implementing alternative BMPs, turbidity levels were brought back into compliance in a relatively short time frame.

Analysis of monitoring methodology and usefulness of data resulted in several improvements to the monitoring plan for the upcoming years. Habitat mapping will be integrated with thalweg and cross section surveys to improve accuracy and repeatability. Microhabitat measurements will target rearing and spawning habitat in comparison to local reference sites rather than to values provided in the literature. Measurements of additional habitat variables, bank stability, overhanging vegetation, and undercut banks will be added to the effectiveness monitoring parameters to improve documentation of fish habitat enhancements resulting from the restoration activities.

CHAPTER 7

EDUCATION AND PUBLIC INFORMATION

The original, turn-of-the-century Red River schoolhouse is located on the RRWMA, giving the property historical value as well as restorative potential for fish and wildlife habitat and educational opportunities for humans.

The potential to create a conservation education center on the Red River Wildlife Management Area (RRWMA), formerly the Little Ponderosa Ranch, was a primary factor in the collaborators' enthusiasm to purchase the property.
The combination of existing and potential fish and wildlife habitat, the stream restoration demonstration project, and the structural facilities (ranch house, caretaker's house, and out-buildings) on the RRWMA offers a unique setting to provide both outdoor and indoor classroom experiences for students of all ages.

Educational materials and indoor learning activities serve to disseminate information regarding successes, challenges, and experiences of the habitat restoration and enhancement efforts on the RRWMA. As an outdoor laboratory, the site is being used as a local and regional model and demonstration project and as a place where humans can observe the implications of fish and wildlife habitat degradation, understand the importance of wise management of watersheds, and appreciate the science of ecological restoration.

7.1 PRELIMINARY INFORMATION AND EDUCATION PLANS

Proposed Information and Education Activities

In 1997, the project team identified a number of education and public outreach activities having the potential to disseminate knowledge and experiences gained from the Lower Red River Meadow Restoration Project. Through these activities and in coordination with IDFG, the project teams hopes to encourage the use of the RRWMA and the restoration project for indoor and outdoor classroom activities. In addition, public outreach activities are necessary to promote the use of the project area as a model or demonstration site for similar projects in the region.

Potential information and education activities and materials include:

- Newspaper articles/news releases
- Public service announcements via radio
- Educational video
- Information brochure
- Journal/magazine articles
- Digital image library
- Interactive educational CD-ROM
- Monthly/quarterly newsletters
- Web page
- On-site tours
- Interpretive nature trail
- 2-3 day teacher/student workshops
- Poster display
- Slide presentations
- On-site signage

IDFG Educational Management Plan

As one of the initial collaborators and visionaries in the purchase of the Little Ponderosa Ranch and the current owner and manager of the RRWMA, IDFG has a strong interest in the natural resources education potential of this property. In 1996, the IDFG drafted an education management plan for the property.

The plan contains the following goals and associated objectives:

Goal 1. Encourage cooperative education projects with local, private, state, and federal groups and individuals.

Primary Objectives:
- Establish an outreach program
- Establish a Watchable Wildlife Program
- Cooperate on future project as opportunities arise

Goal 2. Provide a setting for natural resource oriented education and research.

Primary Objectives:
- Cooperate with existing teacher education programs
- Cooperate with existing outdoor school programs
- Serve visiting school groups

Goal 3. Provide a meeting facility for natural resource oriented agencies and organizations and the local community.

Primary Objective:
- Establish a facility rental program

7.2 EDUCATION AND PUBLIC INFORMATION ACCOMPLISHMENTS

By the end of 1997, the project team and IDFG accomplished several education and public information activities.

PUBLIC INFORMATION MEETINGS. Members of the project team discussed restoration goals and objectives with Idaho congressional staff representatives in May 1996. During this same month, public meetings were held in Elk City and Grangeville and information sheets were distributed to neighbors in the lower meadow.

ON-SITE TOURS. On-site tours were provided to:

- Stream Restoration Projects Assessment Team comprised of fishery biologists and hydrologists from the US Forest Service and University of Utah.

- Idaho County Soil and Water Conservation District Board of Supervisors.
- Idaho County Soil and Water Conservation District Assistants.
- Idaho Division of Environmental Quality.
- Nez Perce National Forest employees.

WATCHABLE WILDLIFE PLATFORM. During the field season of 1997, IDFG staff began work on the Watchable Wildlife Platform, located next to the RRWMA Ranch House. Funding for this project was secured from the Bureau of Land Management and Pepsi-Cola.

ON-SITE INFORMATIONAL SIGNAGE. Two 4'x 8' (1.2 m x 2.4 m) informational signs were created illustrating before and after channel alignments. Associated text describes project benefits to fish and wildlife. Sign text also includes names of the project funding source, sponsor, and agency and organization collaborators. The signs were installed on-site at both entrances to the property – one at the Watchable Wildlife Platform and the other upstream at the Cartwright Creek entrance to the RRWMA.

PROJECT BROCHURE. The first version of the project brochure was designed and printed. The brochures were placed in the RRWMA Ranch House and distributed to neighboring landowners, local businesses in Elk City, the Red River and Elk City Ranger Stations, TAC members, ISWCD office, Nez Perce Forest Supervisor's Office, and consultants. Brochures were also available at meetings, conferences, informational presentations, and other related activities.

ILLUSTRATIVE DRAWINGS. A set of 12 artistic drawings of restoration designs were prepared by a landscape architect and used for discussion in TAC and ISWCD Board meetings. The drawings were patterned after the engineering drawings but in color and more visual. These color drawings were later mounted on foam core board in poster size [2' x 3' (0.6 x 0.9 m)], displayed in the construction office, and became an initial point of project description for on-site tours. Three sets of 11" x 17" (28 cm x 43 cm) sized color drawings were also produced. Two sets were laminated for protection and used for illustration when guiding on-site walking tours.

SLIDE PRESENTATIONS. A project slide show was presented to the Columbia Basin Fish and Wildlife Authority in March 1997.

CD-ROM IMAGE LIBRARY. Approximately 200 images are contained on two CD-ROMs. The project purchased four copies of each to be shared amongst the project team.

TELEVISION DOCUMENTATION. On-site filming of the project site occurred on two occasions:

- May 6, 1997 – Filmed by Mr. Steve Ritter of Idaho Farm Bureau and director of the television program *Idaho Agriculture.*
- August 4-5, 1997 – Film by crew from IDFG's *Incredible Idaho* television program. The program aired on September 27, 1997.

STUDENT FIELD TRIPS. A University of Idaho civil engineering class, under the supervision of Dr. Peter Goodwin, utilized the RRWMA facilities and the stream restoration site for a surveying exercise field trip the weekend of October 17-18, 1997.

7.3 FUTURE EDUCATIONAL AND PUBLIC INFORMATION PLANS

The initial educational and public information materials and activities have been well received and have generated additional interest in the site from a number of groups.

The project team plans to enhance and accelerate these educational and public outreach efforts in cooperation with IDFG, University of Idaho, education-based foundations, and local and regional school districts and community organizations. The following information and education materials and activities are planned for future years:

- Slide presentations and poster display
- FACT Sheet/ Newsletters
- Web site
- Journal articles
- Surveillance/underwater cameras
- Curriculum for 2-3 day student workshops
- Interpretive trail
- Student surveying/monitoring projects
- Update brochure, image library, and on-site signage

SUMMARY AND CONCLUSIONS

Adult chinook salmon (Onchorychus tschawya), one of the target species for the Lower Red River Meadow Restoration Project (Photo courtesy of IDFG).

The Lower Red River Meadow Restoration Project was initiated to restore and enhance fish and wildlife habitat in a meadow reach considered a high priority for restoration activities. Human impacts on several geographic scales have led to the current degraded channel and habitat conditions in the Red River watershed, classified as a "historic stronghold" for spring chinook salmon, steelhead trout, bull trout, and westslope cutthroat trout. The project team uses a natural channel design and an ecosystem approach to stabilize the river channel, reestablish the native riparian plant communities, and enhance the quantity and quality of fish and wildlife habitat.

A natural channel design will result in a minimum maintenance condition since the native vegetation and river ecosystem will be self-sustaining and able to adjust to natural perturbations, such as flooding, sediment scour, and deposition. An ecosystem approach restores the natural relationships among the river channel, floodplain, riparian corridor, wet meadow, and adjacent upland habitats. Therefore, benefits accrue not only to fish and aquatic organisms, but also to waterfowl, wetland- and riparian-dependent species, and upland wildlife.

Two years of planning, two years of restoration work, and one year of post-restoration monitoring are complete. Project planning began in 1994 and resulted in the overall goal or mission statement, restoration philosophy, general objectives, and conceptual restoration design alternatives for Phases I and II on the Red River Wildlife Management Area (RRWMA).

Phase I restoration began in June 1996; Phase II began in June 1997. Channel realignment in Phases I and II included reconnecting two historic channel meanders, constructing two new meanders, and accentuating three existing outside bends. As a result, channel length on the entire RRWMA increased by 3,060 feet (933 meters), channel gradient decreased by 25 percent, and sinuosity increased from 1.7 to 2.3. In addition, fish habitat area increased by approximately 35 percent on the entire RRWMA and by nearly 95 percent in Phases I and II alone.

Channel cross-sectional shapes and point bars were modified or created to maintain deep pool habitat during low flows, convey average annual flows within the channel, and dissipate flood flows onto the floodplain. Six rock grade control structures were installed to raise low flow surface water and groundwater elevations. A pond/wetland area was created and several log habitat structures were keyed into outside streambanks.

During the 1996 and 1997 field seasons, 31,500 woody and herbaceous riparian plants were planted in a 20-foot (6-meter) riparian buffer along the stream reaches of Phases I and II. An erosion control seed mix was sown on all areas disturbed by construction and on equipment travel corridors. Coir fiber erosion control matting was installed on four reinforced banks. Eight wildlife exclosures were constructed and planted with native woody species to limit and monitor ungulate browsing and to quickly establish dense islands of vegetation for future seed sources.

The post-construction monitoring program began in 1997 to assess the short- and long-term effectiveness of the restoration design and implemented features. Results are encouraging. With one exception (turbidity levels occasionally exceeded water quality standards for a limited time), the project's short-term, or implementation, performance was successful.

Post-restoration measurements of sinuosity, gradient, pool numbers, and average residual pool depth also achieved the established performance criteria. For example, both the number of pool/riffle sequences and residual pool depths increased by approximately 60 percent. Analyses of the remaining long-term, effectiveness parameters document either baseline post-restoration conditions or early stages of evolution toward desired conditions. These current baseline and evolutionary conditions are anticipated since a state of dynamic equilibrium is expected to evolve during the next several years or even decades. Tracking the incremental steps of this evolution allows the use of adaptive management principles to identify the most effective restoration techniques that optimize ecologic, geomorphic, and hydrologic conditions in the long-term.

The project team gained valuable experience in several areas of river restoration. Lessons were used to modify and improve designs for cross section dimensions and habitat features, develop best management practices for construction sequencing and above average rainfall and stream discharge conditions, and refine turbidity monitoring protocol.

The RRWMA provides a unique setting for both indoor and outdoor classroom experiences. The site is being used as a local and regional model and demonstration project to share the successes, challenges, and experiences of the habitat restoration and enhancement efforts. In future years, the project team plans to enhance and accelerate educational and public outreach efforts in cooperation with IDFG, University of Idaho, education-based foundations, and local and regional school districts and community organizations.

Engineering and revegetation accomplishments during the first two years of this multi-phase project represent the initial steps toward the evolution of the Lower Red River into a state of dynamic equilibrium. As the channel stabilizes with time, reduced stream bank and bed erosion rates, improved water quality, and enhanced quantity and quality of fish habitat are expected.

Increases in both surface water and groundwater elevations will provide soil moisture conditions conducive for the establishment and sustainability of native riparian plant communities. Deep and fibrous root systems from riparian vegetation will bind and protect streambank soils and develop stable undercut banks. Overhanging branches will provide shade and cover for fish and nutrient sources for aquatic organisms. A dense and diverse riparian community will also enhance wildlife habitat by providing food, cover, and nesting habitat for waterfowl, other birds, and terrestrial mammals.

Work on the Lower Red River Meadow Restoration Project will move into Phases III and IV during the next two years. Continued restoration successes and conservation education opportunities on the Red River Wildlife Management Area are expected to encourage habitat protection and improvement within the entire Red River drainage and to advance knowledge of ecological restoration and the wise management of watersheds.

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APPENDIX A

PLANT SURVEY SPECIES LIST

APPENDIX A

Current plant species, hypothesized original woody vegetation, and plant associations in the Lower Red River Meadow (Brunsfeld, 1994; Duebendorfer, 1997,1998).

Scientific Name	Common Name	Association*			
		D/UM	WM	IS	ORV
Achillea millefolium	yarrow	X			
Agrostis alba	redtop	X			
Agrostis stolonifera	bentgrass	X	X		
Alnus incana	thinleaf alder				X
Alopecurus pratensi/saequalis	meadow/shortawn foxtail	X	X		
Antennaria microphylla	rosy everlasting	X			
Arnica sororia	arnica	X	X		
Aster modestus	great northern aster	X	X		
Botrychium multifidum	leathery grape-fern	X	X		
Camassia quamash	camas	X	X		
Campanula rotundifolia	Scotch bellflower	X			
Carex athrostachya	slender beak sedge	X	X		
Carex lanuginosa	wooly sedge		X		
Carex lenticularis	Shore/lens sedge		X	X	
Carex microptera	small wing sedge	X	X		
Carex praegracilis	clustered field sedge	X	X		
Carex rostrata	Beaked sedge			X	
Carex vesicaria	inflated sedge			X	
Cerastium arvense	mouse-ear chickweed	X			
Chrysanthemum leucanthemum	ox-eye daisy	X			
Cirsium arvense	Canada thistle	X	X		
Collinsia parviflora	few flowered blue-eyed Mary	X	X		
Collomia linearis	narrow-leaf collomia	X			
Cornus stolonifera	red-osier dogwood				X
Dactylis glomerata	orchard grass	X			
Danthonia californica	California oatgrass	X			
Danthonia intermedia	Vasey/timber oatgrass	X			
Delphinium depauperatum	larkspur	X			
Deschampsia caespitosa	tufted hairgrass	X	X	X	
Eleocharis palustris	creeping spike rush			X	
Equisetum arvense	field horsetail	X	X		
Erigeron sp	erigeron	X			
Fragaria virginiana	Virginia strawberry	X			
Galium boreale	northern bedstraw	X	X		
Geum triflorum	Prairie smoke avens	X			
Glyceria elata	tall mannagrass		X		
Glyceria occidentalis	western mannagrass		X		
Heracleum lanatum	cow parsnip		X		
Juncus alpinus	Richardson's/northern rush		X		
Juncus balticus	Baltic rush		X	X	
Juncus confusus	Colorado rush	X	X		
Juncus ensifolius	dagger-leaf rush		X	?	
Juncus longistylis	long-style rush		X		
Juncus nevadensis var *nevadensis*	Sierra rush	X	X		
Juncus tenuis	slender rush	X	X		
Lonicera involucrata	bearberry honeysuckle				X
Lupinus polyphyllus	large-leaved lupine	X	X		
Luzula campestris var *multiflora*	common woodrush	X	X		
Microseris sp	microseris	X			
Montia chamissoi	Chamiss's miner's-lettuce		X		
Nasturtium officinale	true water-cress			X	
Pedicularis groenlandica	Elephant's head lousewort		X	X	

APPENDIX A

(cont.) Current plant species, hypothesized original woody vegetation, and plant associations in the Lower Red River Meadow (Brunsfeld, 1994; Duebendorfer, 1997,1998).

Scientific Name	Common Name	Association*			
		D/UM	WM	IS	ORV
Penstemon confertus	penstemon	X			
Penstemon rydbergii	Rydberg's penstemon		X		
Perideridia gairdneri/oregana	yampah/Oregon yampah	X			
Phalaris arundinacea	reed canarygrass	X	X		
Phleum pratense	timothy	X			
Pinus contorta	lodgepole pine	X			
Poa pratensis	Kentucky bluegrass	X	X		
Polygonum bistortoides	American bistort	X	X		
Potentilla gracilis	northwest cinquefoil	X	X		
Prunella vulgaris	all-heal		X		
Ranunculus alismaefolius var *alismellus*	dwarf buttercup		X	X	
Ranunculus orthorhynchus	straight-beak buttercup		X		
Ranunculus uncinatus var *uncinatus*	hooked buttercup	X			
Rorippa curvisiliqua	curve-pod yellow cress	X		X	
Rumex acetosella	sheep sorrel	X			
Rumex crispus	curly dock	X	X		
Salix boothii	Booth willow				X
Salix drummondiana	Drummond willow				X
Salix geyeriana	Geyer willow				X
Salix lasiandra var. caudatum	whiplash willow				X
Salix melanopsis	sandbar willow				X
Scirpus microcarpus	small-fruited bulrush			X	
Senecio foetidus	sweet marsh groundsel	X	X		
Sisyrhinchium angustifolium	pointed blue-eyed grass	X			
Stellaria longifolia	long-leaf starwort		X		
Stipa occidentalis var *minor*	western needle grass	X			
Taraxacum officinale	dandelion	X	X		
Trifolium repens	white clover	X	X		
Trifolium wormskjoldii/longipes (? species)	clover	X	X		
Vulpia bromoides (? species)	annual fescue	X			

* **D – Disturbed Area**: Clearly ruderal vegetation, along access road/bridge area
UM – Upland Meadow: Areas typically considered upland, these species often used to assist in demarcating wetland/upland boundary
WM – Wet Meadow: Areas typically considered within wetland boundaries, unless wetland hydrology not observed.
IS – Inundated Slough [oxbow]: Areas inundated at least 6 inches as observed mid-June 1997, 1998.
ORV –Original Riparian Vegetation (hypothesized) - woody species only

APPENDIX B

FISH POPULATION SURVEY DATA TABLES

APPENDIX B

Summary of snorkeling observations (fish/100 m^2) in the Lower Red River Meadow Restoration Project area, July, 1986-98. Verified from General Parr Monitoring Database, 1986-1998 (Jody Brostrom, IDFG Regional Fishery Biologist).

Stream	Area	Steelhead Trout				Chinook Salmon		Cutthroat Trout		Bull	Mountain	Brook
Transect	(m^2)	Age 0	Age 1	Age 2	Age >2	Age 0	Age 1	<12 in	>12 in	Trout	Whitefish	Trout
Gibler 3 (uppermost transect in lower meadow)												
1993	668	0.00	0.15	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.30	0.00
1994	547	0.00	0.37	0.00	0.00	39.52	0.18	0.00	0.00	0.00	0.55	0.18
1995	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1996	763	0.00	0.13	0.00	0.00	0.39	0.00	0.13	0.00	0.00	0.00	0.00
1997	798	0.00	0.00	0.00	0.00	1.50	0.00	0.13	0.00	0.00	0.00	0.00
1998	955	0.31	0.00	0.21	0.00	32.78	0.00	0.00	0.00	0.00	2.93	0.10
Gibler 2												
1993	892	0.00	0.00	0.00	0.00	1.34	0.00	0.00	0.00	0.00	0.00	0.00
1994	966	0.00	0.00	0.00	0.00	5.48	0.00	0.10	0.00	0.00	0.10	0.00
1995	611	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.16
1996	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1997	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1998	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Gibler 1												
1993	882	0.00	0.00	0.00	0.00	3.52	0.00	0.00	0.00	0.00	0.00	0.00
1994	866	0.00	0.00	0.00	0.00	8.09	0.00	0.00	0.00	0.00	0.12	0.35
1995	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1996	1594	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	1510	0.00	0.00	0.00	0.00	2.72	0.00	0.00	0.00	0.00	0.40	0.00
1998	1395	0.07	0.00	0.00	0.00	14.63	0.00	0.00	0.00	0.00	2.80	0.00
LP4 (Red River Wildlife Management Area) *Note: New channel constructed in 1996 – Phase I												
1994	603	0.00	0.00	0.00	0.00	18.25	0.00	0.00	0.00	0.00	3.65	0.00
1995	633	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.79	0.00
1996	1116	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.18	0.00
1997	504	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
1998	735	0.00	0.00	0.00	0.00	25.45	0.00	0.00	0.00	0.00	4.49	0.00
LP3 (Red River Wildlife Management Area) *Note: New channel constructed in 1997 – Phase II												
1994	558	0.00	0.00	0.00	0.00	11.48	0.00	0.00	0.00	0.00	5.02	0.00
1995	675	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00
1996	972	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.21	0.00
1997	661	0.00	0.00	0.00	0.00	3.18	0.00	0.00	0.00	0.00	1.21	0.15
1998	533	0.38	0.00	0.00	0.00	17.64	0.00	0.00	0.00	0.00	1.69	0.00

APPENDIX B

(cont.) Summary of snorkeling observations (fish/100 m²) in the Lower Red River Meadow Restoration Project area, July, 1986-98. Verified from General Parr Monitoring Database, 1986-1998 (Jody Brostrom, IDFG Regional Fishery Biologist).

Stream Transect	Area (m²)	Steelhead Trout Age 0	Steelhead Trout Age 1	Steelhead Trout Age 2	Steelhead Trout Age >2	Chinook Salmon Age 0	Chinook Salmon Age 1	Cutthroat Trout <12 in	Cutthroat Trout >12 in	Bull Trout	Mountain Whitefish	Brook Trout
LP2 (Red River Wildlife Management Area) *Note: Proposed Phase III												
1994	497	0.00	0.00	0.00	0.00	48.94	0.00	0.00	0.00	0.00	7.65	0.00
1995	697	0.14	0.00	0.00	0.00	0.72	0.00	0.00	0.00	0.00	3.44	0.29
1996	577	0.00	0.52	0.00	0.00	1.91	0.17	0.00	0.00	0.00	6.76	0.00
1997	699	0.00	0.00	0.14	0.00	9.44	0.00	0.14	0.00	0.00	2.43	0.43
1998	652	0.61	0.00	0.00	0.00	15.80	0.00	0.00	0.00	0.00	23.47	0.00
LP1 (Red River Wildlife Management Area) *Note: Proposed Phase IV												
1994	602	0.00	0.17	0.17	0.00	31.07	0.00	0.00	0.00	0.00	9.30	0.00
1995	980	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.00	0.20	0.00
1996	1063	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.41	0.00
1997	1515	0.00	0.00	0.07	0.00	2.57	0.00	0.00	0.00	0.00	0.86	0.07
1998	1625	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.00	0.49	0.00
Johnson Upper												
1993	807	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	1.73	0.00
1994	672	0.00	0.00	0.00	0.00	3.87	0.00	0.00	0.00	0.00	1.79	0.00
1995	ND	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
1996	713	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	0.00
1997	822	0.00	0.00	0.12	0.00	1.46	0.00	0.00	0.00	0.00	0.31	0.36
1998	1329	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	1.50	0.00
Johnson Lower												
1993	1035	0.00	0.00	0.00	0.00	0.10	0.00	0.29	0.00	0.00	2.61	0.00
1994	896	0.00	0.00	0.00	0.00	4.69	0.11	0.22	0.00	0.00	11.95	0.11
1995	1188	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	7.41	0.00
1996	1247	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.92	0.00
1997	1590	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.06	0.00	3.14	0.06
1998	1035	0.00	0.00	0.00	0.00	0.97	0.00	0.10	0.00	0.00	0.97	0.00

APPENDIX B

(cont.) Summary of snorkeling observations (fish/100 m^2) in the Lower Red River Meadow Restoration Project area, July, 1986-98. Verified from General Parr Monitoring Database, 1986-1998 (Jody Brostrom, IDFG Regional Fishery Biologist).

Stream	Area	Steelhead Trout				Chinook Salmon		Cutthroat Trout		Bull	Mountain	Brook
Transect	(m^2)	Age 0	Age 1	Age 2	Age >2	Age 0	Age 1	<12 in	>12 in	Trout	Whitefish	Trout
Red River (Strata 5, control 2)												
1986	504	7.54	16.47	2.58	0.00	49.40	0.00	0.20	0.00	0.00	4.56	0.00
1987	658	1.22	7.30	0.61	0.00	11.86	0.00	0.15	0.00	0.00	6.99	0.00
1988	720	7.36	0.28	0.00	0.14	19.58	0.42	1.25	0.00	0.00	0.28	0.00
1989	712	0.56	0.84	0.28	0.00	1.55	0.56	0.00	0.00	0.00	5.34	0.00
1990	962	0.52	0.52	0.10	0.00	0.00	0.00	0.10	0.00	0.00	2.81	0.00
1991	762	0.39	0.00	0.13	0.00	1.18	0.00	0.79	0.00	0.00	0.66	0.00
1992	808	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00
1993	1101	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00
1994	754	0.00	0.27	0.13	0.00	11.54	0.00	0.00	0.13	0.00	0.40	0.27
1995	1287	0.00	0.00	0.08	0.00	0.23	0.00	0.00	0.00	0.00	0.93	0.00
1996	1162	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.26	0.00
1997	1180	0.00	0.00	0.00	0.00	8.30	0.00	0.00	0.00	0.00	6.95	0.00
1998	982	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.31	0.00
Red River (Strata 5, treatment 2)												
1986	1001	1.60	10.89	0.50	0.00	15.08	0.00	0.10	0.00	0.00	4.39	0.00
1987	1184	0.00	5.15	0.17	0.00	9.46	0.00	0.00	0.00	0.00	3.13	0.00
1988	1140	0.79	0.35	0.18	0.00	3.25	0.00	0.61	0.00	0.00	1.14	0.00
1989	1187	0.17	1.35	0.08	0.00	1.35	0.25	0.00	0.00	0.08	0.93	0.00
1990	1063	0.85	0.09	0.75	0.00	1.22	0.19	0.00	0.00	0.00	11.29	0.00
1991	2089	0.05	0.10	0.00	0.00	0.53	0.00	0.24	0.00	0.00	1.43	0.00
1992	2864	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00
1993	2236	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00
1994	692	0.29	0.00	0.00	0.00	4.77	0.00	0.00	0.00	0.00	1.88	0.00
1995	2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.93	0.00
1996	2002	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.60	0.00
1997	1859	0.00	0.05	0.00	0.05	0.05	0.05	0.00	0.00	0.00	1.67	0.00
1998	987	0.00	0.00	0.00	0.00	2.43	0.00	0.00	0.00	0.00	0.10	0.00

2 adult chinook – 1998

APPENDIX C

FEEDBACK LOOP REPORT TO THE DEPARTMENT OF ENVIRONMENTAL QUALITY: EXCEEDANCE OF WATER QUALITY STANDARDS

APPENDIX C

Lower Red River Meadow Restoration Project

1997 Construction Period (July 1 - August 15)
Exceedance of DEQ Water Quality Standards
Feedback Loop Report

Background

The overall goal of the Lower Red River Meadow Restoration Project is to restore this 320 acre site to a diverse meadow ecosystem with a sinuous stream channel, dense riparian vegetation, various wetland types, and multiple fish habitat types and features. Constructing the restoration design features requires the use of heavy equipment and instream work, for which a stream alteration permit was obtained. There were several incidences when, despite the use of planned BMPs, the project exceeded water quality standards.

The project timed the turbidity events so that the downstream impacts to the dredge miners would be minimized. However, we learned (from careful turbidity monitoring at three datalogger stations downstream from the construction area) that the miners experienced low visibility problems at 6-7 NTUs, well below the set water quality standards of 50 NTUs above background level.

The data below describe the timing and duration of violations to the DEQ water quality standards during the channel reconstruction of Phase II of the Lower Red River Meadow Restoration Project. In addition, construction activities that preceded these events and BMPs used to mitigate for such events are also presented.

The datalogger closest to the construction site was located near the old bridge on the IDFG's Wildlife Management Area property. The next datalogger was located downstream at the Cole Porter Bridge and marked the end of the meadow. The mining dredge nearest the construction site was located 6 miles downstream and the datalogger at Red Horse Creek was approximately 0.6 miles downstream from this dredge.

Day	Time	Data Logger Location	Peak NTU	Duration > 53 NTU
8/5	1606	WMA (old bridge)	86	38 min.
	1910 (est.)	Cole Porter Bridge	32	0
	2054	Red Horse Creek*	23	0

**down to 2.6 NTU at 0600 on 8/6*

1. **Construction Activity related to water quality violation:**
   First attempt at installation of diversion structure (highway barriers) at upstream entrance into historic channel
2. **BMPs utilized to mitigate turbidity release:**
   a) Geotextile sediment control fabric placed on upstream side of highway barriers
   b) Water diverted gradually over time into historic channel to decrease the peak turbidity
   c) Utilized natural, grassed bottom in historic channel as a sediment filter

3. **Reported violation to Daniel Stewart, DEQ-Grangeville, on 8/6/97 via telephone.**

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Day	Time	Data Logger Location	Peak NTU	Duration > 53 NTU
8/6	1346	WMA (old bridge)	288	4 hours 30 minutes
	1732	Cole Porter Bridge	107	2 hours
	1900	Red Horse Creek*	75.5	1 hour 30 minutes

**down to 6.3 NTU at 0700 on 8/7*

1. **Construction activity related to water quality violation:**
   Second attempt at diversion structure (concrete highway barriers) at upstream entrance to historic channel. Rocks and gravel were used to support and stabilize the diversion structure. The water discharge this year was approximately two times the discharge last year at this same time (90 cfs in 1997 vs. 40 cfs in 1996). This unanticipated water discharge required the extension of the diversion structure.

2. **BMPs utilized to mitigate turbidity release:**
   a) Geotextile sediment control fabric placed on upstream side of highway barriers
   b) Timed construction of diversion wall until the afternoon to lessen the effect on the mining activities downstream.
   c) Utilized natural, grassed bottom in historic channel as a sediment filter.

3. **Reported violation to Daniel Stewart, DEQ-Grangeville, on 8/7/97 via telephone.**

Day	Time	Data Logger Location	Peak NTU	Duration > 53 NTU
8/7	1500	WMA (old bridge)	109.5	1 hour 10 minutes
	1910	Cole Porter Bridge	49	0
	2040	Red Horse Creek*	38	0

**down to 4.5 NTU at 0630 on 8/8*

1. **Construction activity related to water quality violation:**
   Approximately 200 feet of the historic channel were excavated down an average of 2 feet from the channel bottom.
2. **BMPs utilized to mitigate turbidity release:**
   a) Timed historic channel excavation until the afternoon to lessen the effect on the mining activities downstream.
   b) Bottom material excavated from centerline to bank, leaving grass/sedge sod intact on banks and opposite half of channel bottom.

3. **Reported violation to Daniel Stewart, DEQ-Grangeville, on 8/8/97 via telephone.**

Day	Time	Data Logger Location	Peak NTU	Duration > 53 NTU
8/8	1600	WMA (old bridge)	409	3 hours
	1940	Cole Porter Bridge	187	2 hours 50 min.
	2120	Red Horse Creek*	160	2 hours 40 min.

**down to 5.3 NTU at 0730 on 8/9*

1. **Construction activity related to water quality violation:**
   a) An additional 100 feet of the historic channel were excavated down an average of 2 feet from the channel bottom. Again, material was scooped from the centerline toward the west side of the channel and piled on the top of the bank.

b) Reinforced bank installed behind the upstream diversion structure at the entrance of the historic channel
c) Removed upstream diversion structure near entrance of historic channel
d) Removed soil plug on downstream end of Giant Bend

2. BMPs utilized to mitigate turbidity release:
a) Installed a diversion structure (highway barriers with geotextile sediment control fabric) at downstream end of former channel to block sediment release from the construction of the small reinforced bank and backfilling of the former channel area
b) An efficient 6-inch pump was used to remove turbid water from the former channel area. This turbid water was pumped into a wetland swale on the west side of the stream channel to keep it from flowing back into the live stream channel. These actions were a major improvement over the 1996 BMPs when smaller pumps could not remove the turbid water at a sufficient rate.

3. Reported violation to Daniel Stewart, DEQ-Grangeville, on 8/10/97 via fax.

Day	Time	Data Logger Location	Peak NTU	Duration > 53 NTU
8/11	1920	WMA (old bridge)	286	3 hours 40 min.
	2230	Cole Porter Bridge	74	1 hour 50 min.
	0010	Red Horse Creek*	61	1 hour 20 min.

**down to 5.5 NTU at 0650 on 8/12*

1. Construction activity related to water quality violation:
Excavated the downstream section of the historic channel 2 to 3 feet below the existing channel bottom

2. BMPs utilized to mitigate turbidity release:
a) Timed the majority of the excavation until later in the afternoon to lessen impacts on miners.
b) Nearly all of the grass/sedge sod lining the channel banks was left intact.

3. Reported violation to Daniel Stewart, DEQ-Grangeville, on 8/12/97 via fax.

Day+	Time	Data Logger Location	Peak NTU	Duration > 53 NTU
8/12	1710	WMA (old bridge)	159	3 hours 50 minutes
	1310	WMA (old bridge)	112	50 minutes
	1530	WMA (old bridge)	221	2 hours 50 minutes
	1420	Cole Porter Bridge	73	50 minutes
	1700	Cole Porter Bridge	58	30 minutes
	1910	Cole Porter Bridge	82	2 hours 20 minutes
	1600	Red Horse Creek*	58	20 minutes
	2050	Red Horse Creek*	69	50 minutes

+Because several activities throughout the day involved instream work, three separate turbidity events with specific peaks occurred at WMA and Cole Porter and two events occurred at Red Horse Creek. This is in contrast to previous days when only one event occurred at all locations.
**down to 9.0 NTU at 0630 on 8/13*

1. Construction activity related to water quality violation:
a) Additional excavation in the historic channel.

b) Additional excavation of the entrance to Giant Bend and near the tributary inlet to Giant Bend.
c) Instream “footing” prepared prior to installing the upstream diversion structure.
d) Installation of the upstream and downstream diversion structures to divert all water flow through Giant Bend.

2. BMPs utilized to mitigate turbidity release:
a) Diversion structures used to minimize contact between flowing water and disturbed meadow soils
b) Upstream and downstream diversion structures used to contain turbid water until 6-inch pump was installed.

3. Reported violation to Daniel Stewart, DEQ-Grangeville, on 8/13/97 via fax.

Day	Time	Data Logger Location	Peak NTU	Duration > 53 NTU
8/13	1140	WMA (old bridge)	133	50 minutes
	1530	Cole Porter Bridge	48	0
	1710	Red Horse Creek*	38	0

**down to 7.2 NTU at 0800 on 8/14*

1. Construction activity related to water quality violation:
a) Reinforced bank installed behind the upstream diversion structure at the entrance of Giant Bend
b) Soil plug placed against inside of downstream highway barrier diversion structure

2. BMPs utilized to mitigate turbidity release:
a) Diversion structure at downstream end of former channel used to prevent sediment release from the construction of the reinforced bank and turbid water trapped in former channel
b) An efficient 6-inch pump was used to remove turbid water from the former channel area. This water was pumped into a wetland swale on the west side of the stream channel to keep it from flowing back into the live stream channel.

3. Reported violation to Daniel Stewart, DEQ-Grangeville, on 8/14/97 via fax.

Day	Time	Data Logger Location	Peak NTU	Duration > 53 NTU
8/14	1120	WMA (old bridge)	172	1 hour 20 minutes
	1600	Cole Porter Bridge	30	0
	1800	Red Horse Creek*	25	0

**down to 3.97 NTU at 0640 on 8/15*

1. Construction activity related to water quality violation:
a) Removed upstream and downstream diversion structures in the upstream former channel area.
b) Equipment crossed the stream to continue the final grading and shaping on the downstream former channel area and to move materials to the east side of the stream.

2. BMPs utilized to mitigate turbidity release:
a) Excavators worked outside of live water when feasible
b) Equipment crossings were minimized to the extent feasible

3. Reported violation to Daniel Stewart, DEQ-Grangeville, on 8/15/97 via fax.

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Day	Time	Data Logger Location	Peak NTU	Duration > 53 NTU
8/15	0920	WMA (old bridge)	62	20 minutes
	1750	WMA (old bridge)	53	10 minutes
		Cole Porter Bridge+	-	-
		Red Horse Creek*		

+On Friday, the Cole Porter Bridge data logger produced some erroneous measurements, probably due to some type of organic debris collecting on the sensor.
**Red Horse Creek data logger removed Friday a.m.*

1. **Construction activity related to water quality violation:**
   a) Machines crossed stream to complete the final filling, grading, and shaping of the downstream former channel area.
   b) Rock control sill installed downstream from the exit of the historic channel into the existing channel.

2. **BMPs utilized to mitigate turbidity release:**
   a) Excavators worked outside of live water when feasible
   b) Equipment crossings were minimized to the extent feasible

3. **Reported violation to Daniel Stewart, DEQ-Grangeville, on 8/19/97 via fax.**

Appendix D

Technical Advisory Committee Field Reviews: Qualitative Performance Criteria, Evaluation Questions, and Field Review Form

APPENDIX D

Qualitative construction performance criteria for Technical Advisory Committee Field Reviews, Lower Red River Meadow Restoration Project.

FEATURE	FEATURE FUNCTION/EXPECTED RESULTS
NEW MEANDER BEND/RECONNECTED HISTORIC CHANNEL	♦ Lengthens stream channel; re-establishes meander pattern similar to 1936 conditions. ♦ Raises low flow water surface elevation to within 3 feet of top of bank. ♦ Restores floodplain function, increasing the frequency and duration of the meadow hydroperiod. ♦ Increases sinuosity ratio. ♦ Decreases stream gradient. ♦ Re-establishes sediment transport regime to within the range of natural conditions. ♦ Reconnects tributary flows to low flow water elevations in main channel. ♦ Creates or maintains backwater and side channels.
ROCK CONTROL SILL	♦ Elevates low flow surface water elevation to within 3 feet of top of bank. ♦ Collects gravels and cobbles on upstream side, increasing channel bed elevation. ♦ Creates plunge pool directly below on downstream side. ♦ Develops a pool tail-out (riffle) downstream of plunge pool. ♦ Maintains tributary connections with river channel at low flow. ♦ Reconnects or creates backwater/side channels.
NEW OR MODIFIED VERTICAL CUT BANK ON OUTSIDE BENDS (W/O LOG STABILIZATION STRUCTURES)	♦ Initiates scour pool development along outer edge. ♦ Creates deep pools and develops pool-riffle sequences. ♦ Decreases channel width/depth ratio. ♦ Adjusts to and withstands natural stream discharges. ♦ Allows above average stream flows to spread out onto floodplain.
NEW OR MODIFIED VERTICAL CUT BANK ON OUTSIDE BENDS (W/ LOG STABILIZATION STRUCTURES)	♦ Initiates scour pool development along outer edge. ♦ Creates deep pools and develops pool-riffle sequences. ♦ Decreases channel width/depth ratio. ♦ Adjusts to and withstands natural stream discharges. ♦ Allows above average stream flows to spread out onto floodplain. ♦ Log structures deflect water flow and reduce erosive energy. ♦ Localized scour around log structures creates small pools for fish habitat. ♦ Log structures provide shade and cover for fish.
MODIFIED POINT BAR ON INSIDE BENDS (BROAD AND FLAT WITH 2 PERCENT SLOPES)	♦ Allows inundation at lower water elevations, reducing erosive energy on outside bends. ♦ Facilitates the deposition of relatively fine materials, resulting in point bar aggradation and narrowing of channel width.
REINFORCED BANKS	♦ Creates a stable bank at right angles to the old channel flow and diverts water flow into new channels. ♦ Develops localized, lateral scour pools associated with exposed logs for fish habitat. ♦ Erosion control matting placed on top of this bank and planted with native grass seed mix provides erosion protection for exposed soils of the newly filled floodplain area.
VEGETATION	♦ Establishes plant communities with densities and diversity resembling 1936 conditions. ♦ Stabilizes stream banks and reduces erosion. ♦ Facilitates point bar aggradation. ♦ Provides overhanging vegetation, undercut banks, instream debris, and nutrient source. ♦ Shades stream channel, lowering summer water temperatures. ♦ Enhances food, cover, and nesting habitat for waterfowl, birds, and terrestrial wildlife.

APPENDIX D

Questions used to evaluate restoration features during Technical Advisory Committee Field Reviews, Lower Red River Meadow Restoration Project.

FEATURE	EVALUATION QUESTIONS
ROCK CONTROL SILLS	♦ Rock movement? ♦ Surface water elevation control function? ♦ Gravel/cobble deposition upstream? ♦ Scour pool development downstream? ♦ Pool tail-out feature? ♦ Summer water elevations to within 30 to 36 inches of top of bank? ♦ Tributaries maintain connection with river channel at low flow? ♦ Restoration of natural flooding of meadow?
VERTICAL CUT BANKS ON OUTSIDE BENDS (W/O LOG STABILIZATION STRUCTURES)	♦ Bank sloughing; visual evidence of reduced erosion rate? ♦ Channel width? ♦ Deep pool development? ♦ Pool tail-out feature?
VERTICAL CUT BANKS ON OUTSIDE BENDS (W/ LOG STABILIZATION STRUCTURES)	♦ Bank sloughing; visual evidence of reduced erosion rate? ♦ Channel width? ♦ Deep pool development? ♦ Pool tail-out feature? ♦ Log structures intact? ♦ Fish habitat function (i.e., cover; shade; small, lateral scour pools)?
MODIFIED POINT BARS ON INSIDE BENDS	♦ Floodway/energy dissipation function at high flow? ♦ Aggradation (relatively fine materials) occurring to narrow channel width?
REINFORCED BANKS	♦ Extent of erosion (i.e., logs/rocks are in place and secure; only ends of logs exposed)? ♦ Bank stability/channel diversion function? ♦ Erosion/scour on downstream end of old channel due to overland flow at high water? ♦ Erosion control matting/vegetation secure and providing erosion protection?
VEGETATION	♦ Condition? ♦ Bank stabilization function? ♦ Point bar aggradation function? ♦ Habitat features (e.g. overhanging vegetation, undercut banks, instream debris, etc.?) ♦ Wildlife exclosure condition/function?

APPENDIX D

Lower Red River Meadow Restoration Project, Phases I and II
Technical Advisory Committee (TAC) Field Review Form

Evaluator: ____________________ Title:_______________ Affiliation: ________________

Channel Feature	Rating*	Comments
Phase I – 1996 Construction Area		
(1) Two Sill Bend-Reach		
▪ Double Rock Sill		
▪ Accentuated Vertical Cut Bank w/o Log Stabilization Structures		
▪ Vegetation		
(2) Hopeful Barb Bend-Reach		
▪ Upstream Rock Sill		
▪ Accentuated Vertical Cut Bank w/ Log Stabilization Structures		
▪ Modified Point Bar		
▪ Vegetation		
(3) No Touch Bend-Reach		
▪ Upstream Rock Sill		
▪ Tributary		
▪ Unmodified Vertical Cut Bank		
▪ Modified Point Bar		
▪ Reinforced Bank		
▪ Vegetation		
(4) Big Bend-Reach		
▪ Constructed Vertical Cut Bank w/ Log Stabilization Structures		
▪ Modified Point Bar		
▪ Downstream Rock Sill (partial)		
▪ Vegetation		
▪ Reinforced Bank		

***Rating Scale:**
A = Feature is in optimal, properly functioning condition
B = Feature is functioning in an acceptable, evolving condition
C = Feature is acceptable now, but may need modification in the future
D = Feature is in unacceptable condition, modification required as soon as possible

APPENDIX D

(cont.) TAC Field Review Form, Phases I and II, Lower Red River Meadow Restoration Project.

Channel Feature	Rating*	Comments
(5) Goose Island Bend-Reach		
▪ Unmodified Vertical Cut Bank		
▪ Downstream Rock Control Sill		
▪ Vegetation		
(6) Ninety-Degree Bend-Reach		
▪ Unmodified Overflow Channel		
▪ Accentuated Vertical Cut Bank w/o Log Stabilization Structures		
▪ Modified Point Bar		
▪ Vegetation		
Phase II – 1997 Construction Area		
(7) Giant Bend-Reach		
▪ Upstream Reinforced Bank		
▪ Excavated Vertical Cut Bank w/o Log Stabilization Structures		
▪ Modified Point Bar		
▪ Downstream Reinforced Bank		
▪ Constructed Wetland		
▪ Vegetation		
(8) – (11) Historic S-Curve Loops		
▪ Upstream Modified Point Bar		
▪ Excavated Channel Bottom		
▪ Unmodified Outside Bends/Point Bars		
▪ Vegetation		
(12) Temporary Sill Bend-Reach+		
▪ Partially Filled Outside Bend (Downstream end of old channel)		
▪ Unmodified Point Bar		
▪ Rock Control Sill		
▪ Vegetation		

+Currently named Transition Bend

***Rating Scale:**

A = Feature is in optimal, properly functioning condition
B = Feature is functioning in an acceptable, evolving condition
C = Feature is acceptable now, but may need modification in the future
D = Feature is in unacceptable condition, modification required as soon as possible